SAE Journal

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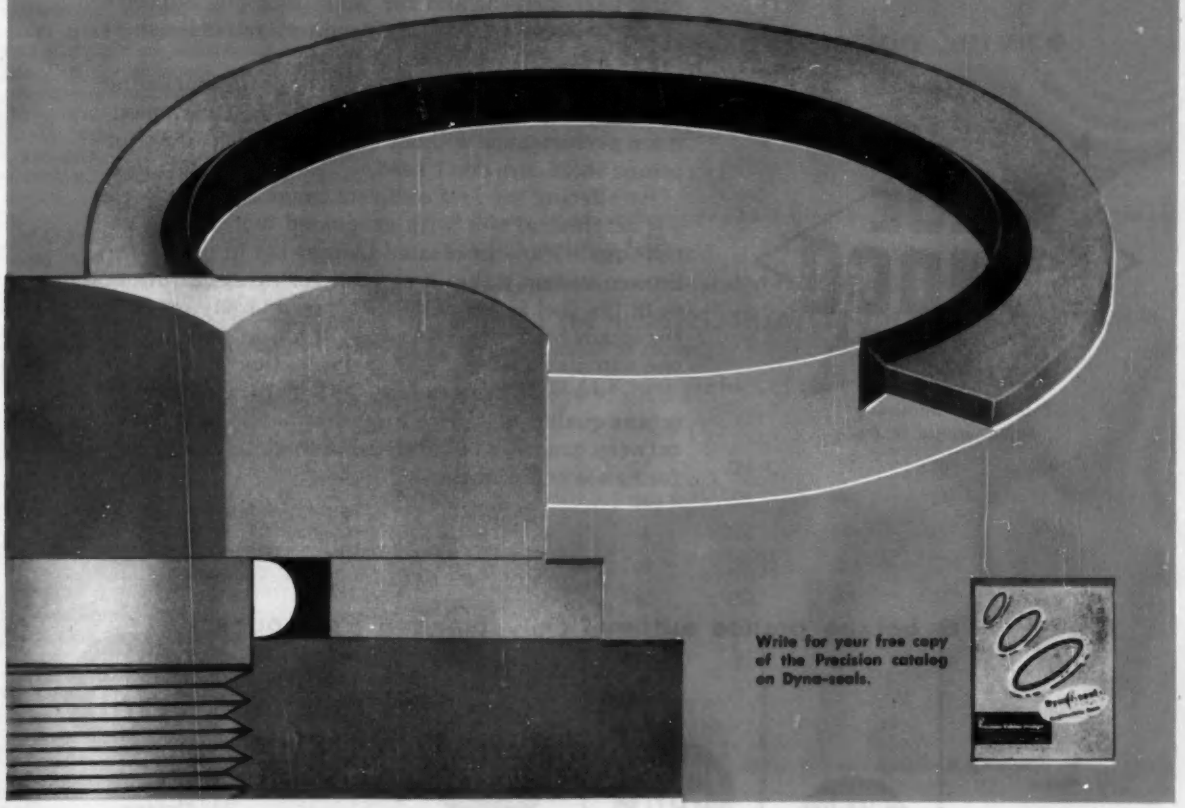
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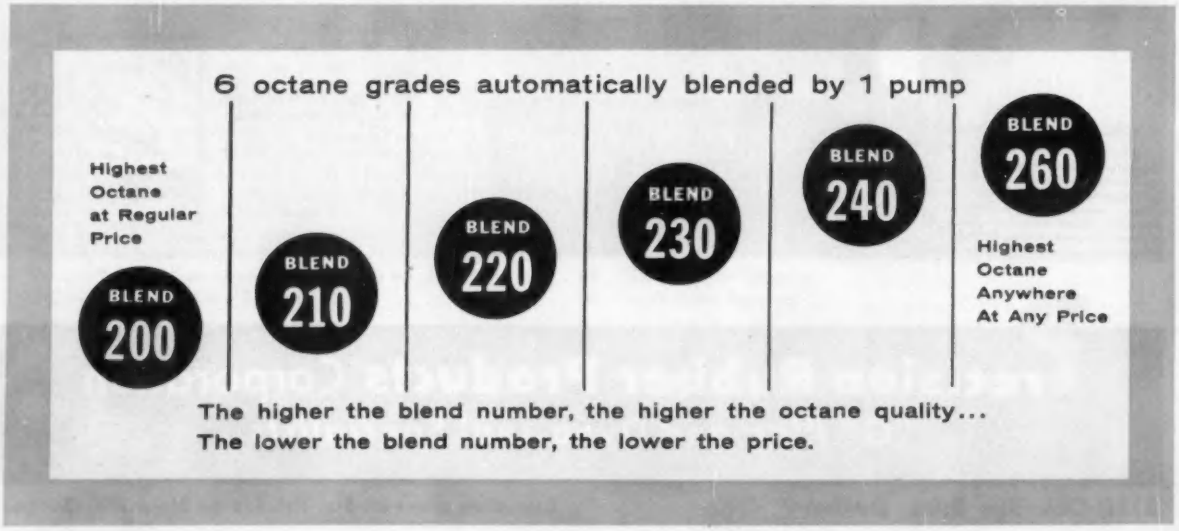
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General Considerations in Transient Isolation Problem, J. T. MULLER. Paper No. 198 presented Sept.-Oct. 1957 7 p. Some of problems of isolation of equipment against dynamic disturbance from engineer's or designer's point of view are considered and character of disturbances and design approaches examined; elements of primitive and simple dynamic system; stress and deformation; oscillatory transients; two ways of incorporating damping; table of damping coefficients.

On Protection of Airborne Equipment Against Shock, C. E. CREDE. Paper No. 199 presented Sept.-Oct. 1957 15 p. Development of criterion of shock damage for application in design and testing of equipment subjected to shock; hypothesis of shock severity is set forth, nature and severity of shock existing in aircraft under certain operation conditions and means to protect airborne equipment against shock.

Analysis of Mechanical Impedance, R. K. COOK. Paper No. 200 presented Sept.-Oct. 1957 9 p. How recognition of certain analogies makes it possible to apply principles for electric circuits to mechanical circuits; application of reciprocal theorem to mechanical networks; use of apparatus and techniques adapted from impedance measurements made on bone structure of head; applications of concepts developed to elastically complex structures, such as soil, building and aircraft structures, etc.

Effects of Machine and Foundation Resilience and of Wave Propagation on Isolation Provided by Vibration Mounts, A. O. SYKES. Paper No. 201 presented Sept.-Oct. 1957 37 p. Based on investigations at David Taylor Model Basin effects on transmission of vibration through isolation mounts of machine and foundation resilience, and of wave propagation are studied and prediction of effectiveness of mounts discussed; curves for estimating effectiveness under certain conditions; mount design and selection; mount formulas.

Measurement of Mechanical Impedance and Its Applications, E. L. HIXSON, A. F. WITTENBORN. Paper No. 202 Sept.-Oct. 1957 20 p. Concept of impedance of mechanical elements is presented by analogy to electric circuits thus making whole field of circuit analysis available for solution of problems in vibration, etc; measurement of mechanical impedance and description of three devices used in soil impedance measurements; impedance computer and recorder; results and examples of applications; pertinence also to aircraft and other structures.

Systems Analysis Approach to Firebee Flight Control Systems Development, C. D. CORDEN, H. J. HANSEN, Jr. Paper No. 203 presented Sept.-Oct. 1957 18 p. Development of procedure based on performance requirements and limitations imposed; analysis of desired performance characteristics guidance system and airframe autopilot requirements by means of functional block diagrams showing feasible system configurations; analog and physical simulation using actual autopilot component resulted in final target system design.

Role of Digital Computers in Airborne Navigation and Control, E. L.

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BRAUN, G. POST. Paper No. 204 presented Sept.–Oct. 1957 9 p. Advantages of digital over analog computers for application in airborne flight control systems and factors to consider in choosing between absolute and incremental type; applications, functions performed and type of computations processed in navigation; automatic flight control; interceptor vectoring and fire control; bombing; idea of centralized digital computer to perform variety of functions.

Airborne Weapons System Development Through Simulation, A. H. NOLL. Paper No. 205 presented Sept.–Oct. 1957 14 p. System design implies that individual component performance is specified by its influence upon desired system performance; simulation by means of computer techniques represents one of basic tools available for analyzing and assessing accuracy, stability and reliability characteristics for any complex nonlinear system; its application to design, development, and evaluation of airborne weapons system; examples.

Future of Weapon System Ground Support, H. B. SIMKINS. Paper No. 207 presented Sept.–Oct. 1957 11 p. It is contemplated that nuclear powered aircraft will be reality in next decade; predictions made, limited to systems of heavy bombardment type, deal with ground support equipment design, manpower and training programs, logistics studies, facilities designs, and maintenance and supportability concepts of each of these; operational environments; three categories of ground support equipment which are foreseen.

GROUND VEHICLES

Human Considerations in Design of Equipment, H. J. BOND. Paper No. 183 presented Sept. 1957 12 p. Term of human engineering, man-machine systems and goals are defined; human errors and reasons for it; tabulation of 227 aircraft pilot error experiences: study shows that errors are increasing function of speed of decision and complexity of display; designing for human use must consider tendency to err and improvement of transfer of information between man and machine; human engineering and industrial automation.

Design Development of Structures for Rubber Tired Construction Equipment by Experimental Stress Analysis, W. P. MACARUS, L. A. GROTTO. Paper No. 182 presented Sept. 1957 8 p. Test information required to redesign International Harvester Model 55 and 75 Payscraper; basic structure of three prototypes of new series 2S-55 were tested on two tracks, one for vertical, and other for twisting and racking loads; results indicate need for improving gooseneck and draft frame arm connections to octagonal section.

Condition of 60 Farm Tractors Points Out Ways to Improve Maintenance, J. A. WEBER. Paper No. 181 presented Sept. 1957 11 p. Results of tractor inspections undertaken at Agricultural Engineering Department of University of Illinois in order to study maintenance practices; inspection procedures; maintenance deficiencies and deficiencies affecting life of tractor parts are tabulated; operator's knowledge of manuals: how to improve maintenance; future research.

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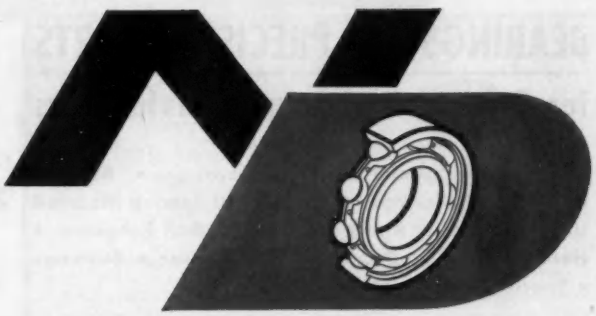
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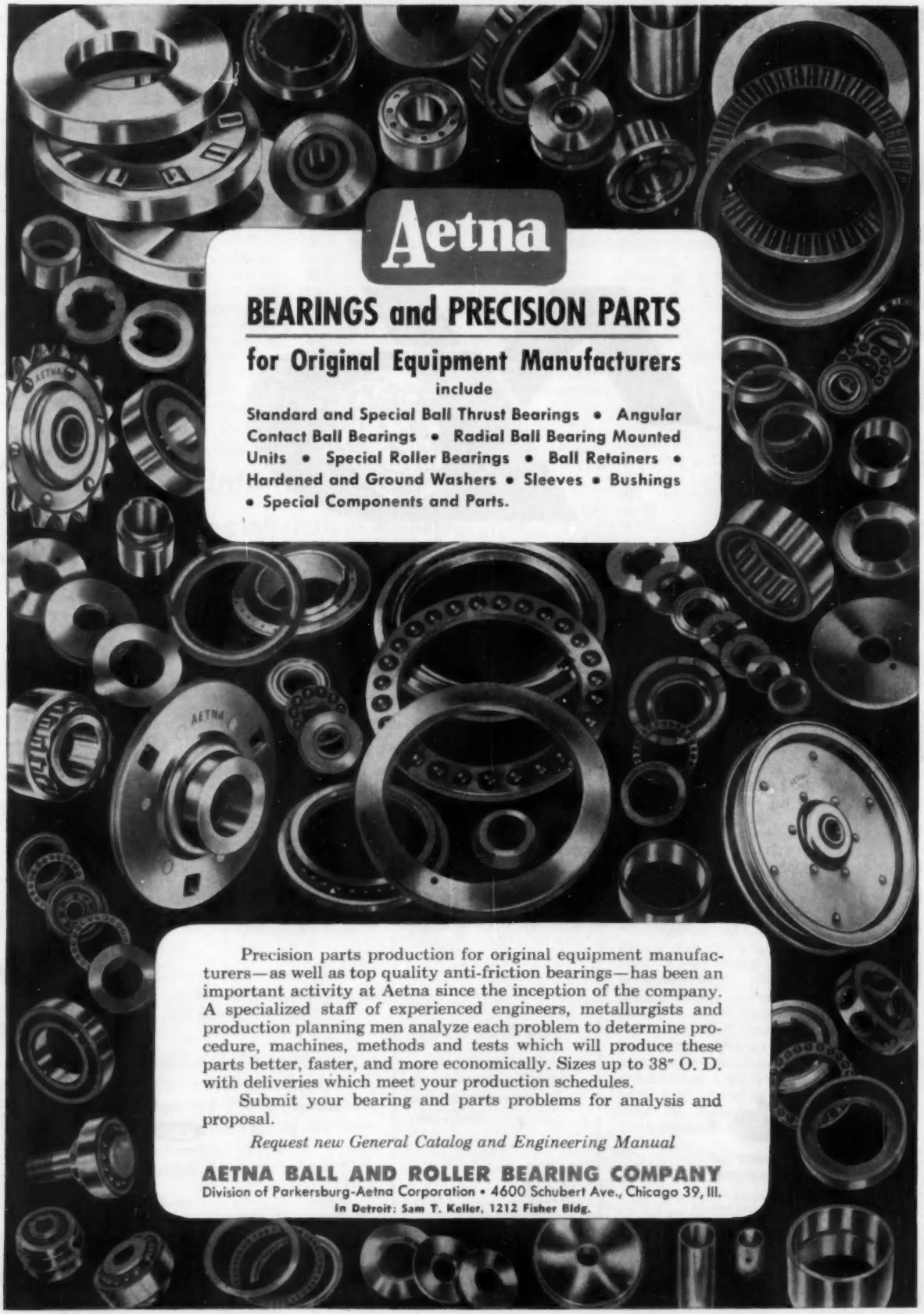
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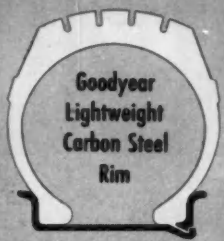
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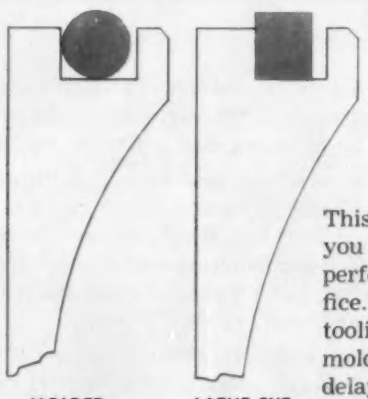
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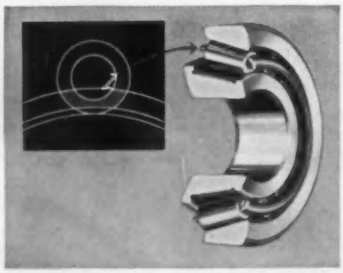
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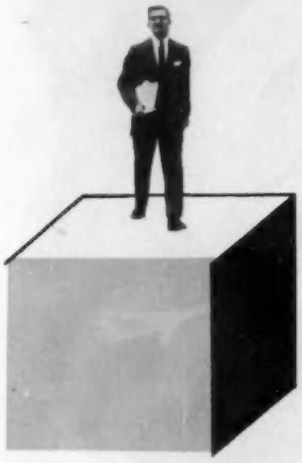
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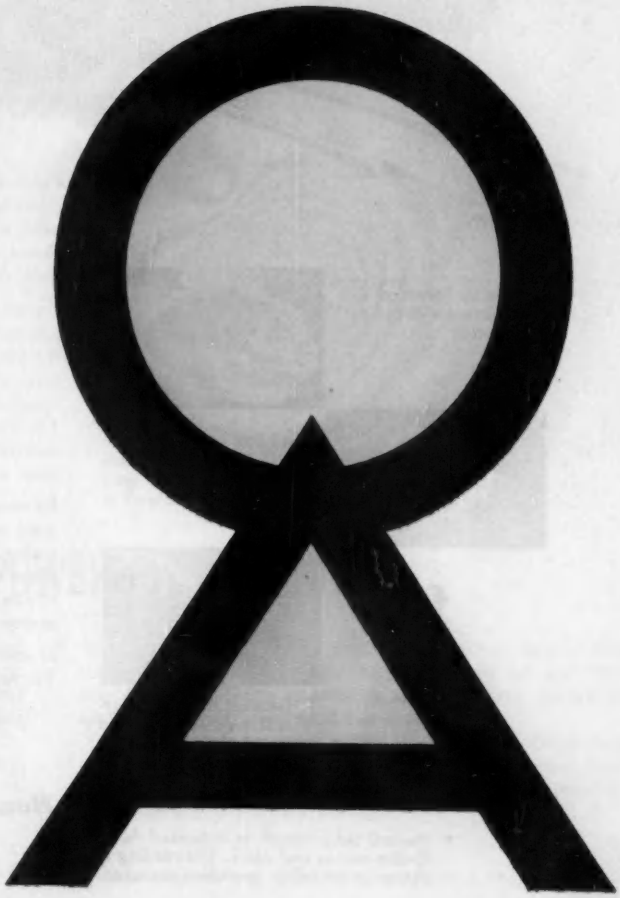
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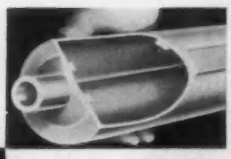


Producing cold-forged rocket launchers for the Chance Vought Crusader is another example of Hunter Douglas ingenuity. The 3" O.D. tube, approximately 100 inches long with an .046" wall, with one end closed, required a fantastic arrangement of internal and external longitudinal ribs, almost impossible to fabricate by conventional methods.

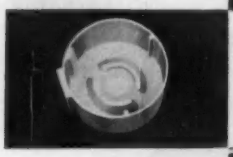
Even cold forging with its ability to integrally form complex part geometry, was put to rigorous tests. For example, cross sections of the tubes were non-symmetrical, generally a serious taboo in cold forging techniques. Further, the non-symmetrical design aggravated longitudinal bow, yet tubes had to be straight within .120" overall. Finally, retention of a minimum wall adjacent to the heavy section presented the problem of uniform metal flow. The heat treated tubes must withstand 1400 psi hydrostatic pressure without deformation.

By combining the varied talents of an experienced engineering staff, good tooling design and sound production techniques, the *cold forged rocket launcher is a fact today*... assembled from two cold forged tubes mechanically joined by a dovetail. Simpler and lighter in design, the cold forged launchers are built to closer tolerances, with greater strength *at less cost!*

If your components can be cold forged, Hunter Douglas can do it! For recommendations, submit your prints or samples.

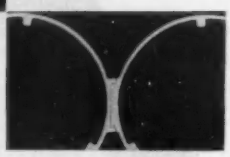


Section is removed to show internal detail of closed end.



• *An end sawed from the full length tube illustrates internal and external ribs as well as end detail.*



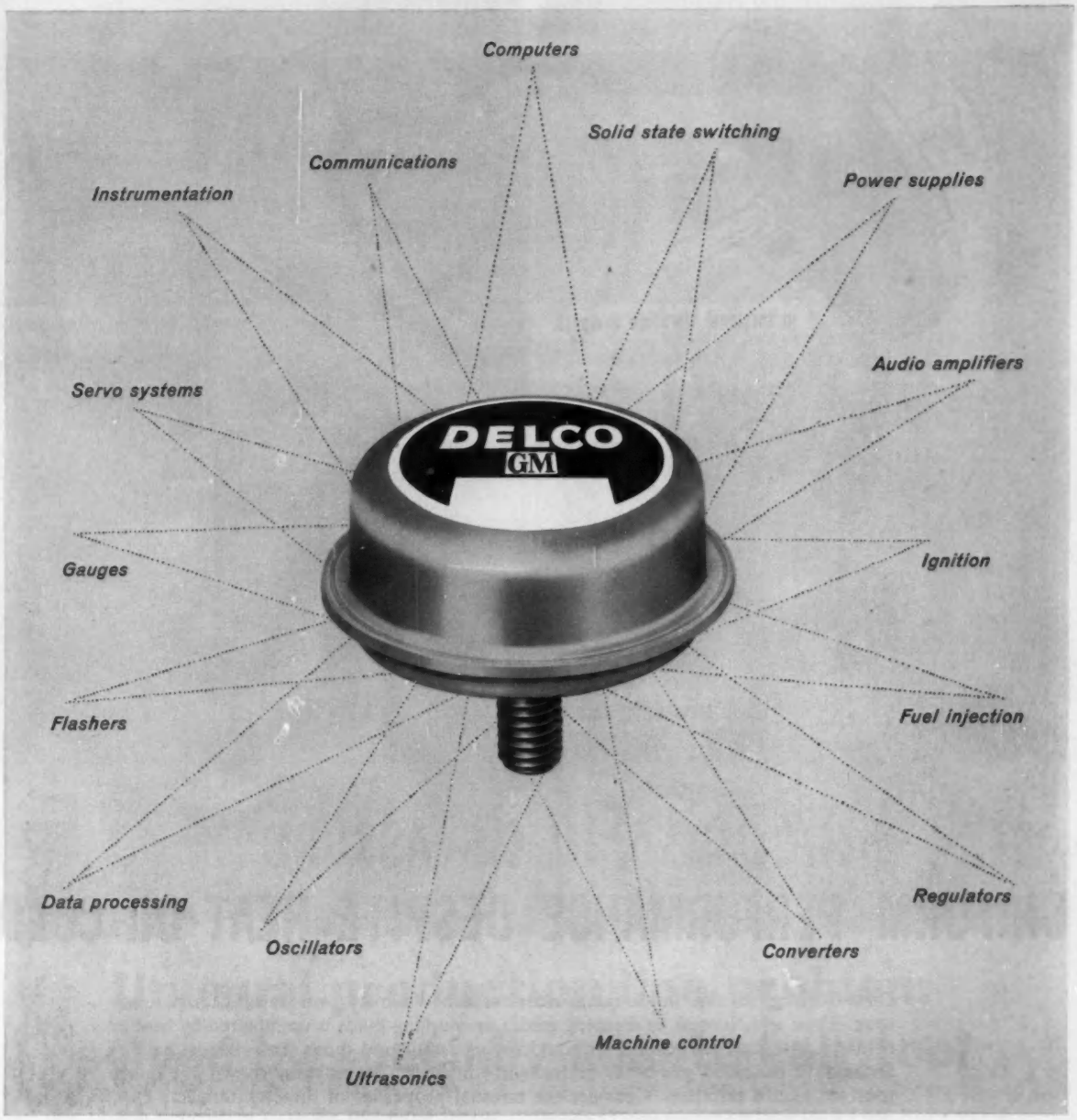


• *Joining the twin barrels was solved by a dovetailing operation. The wide external rib seen in Fig. 2 provides dovetail area.*

• *Overall tube length is indicated here. Entire unit is one piece. Dovetailing is the only assembly operation required.*

Hunter Douglas Aluminum

Division of Bridgeport Brass Company
Dept. SAE-2, Riverside, California • OVerland 3-3030



Wherever you require high power, consider

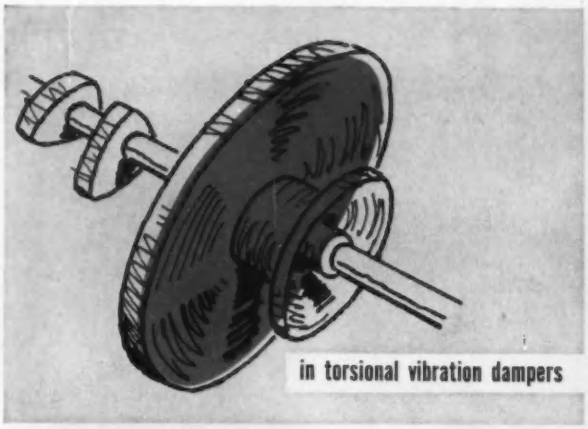
DELCO HIGH POWER TRANSISTORS

Thousands of Delco high power germanium transistors are produced daily as engineers find new applications for them. In switching, regulation, or power supplies—in almost any circuit that requires high power—Delco transistors are adding new meaning to compactness, long life and reliability.

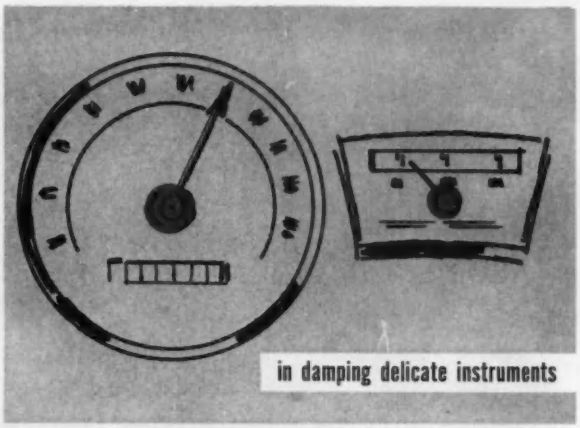
All Delco transistors are 13-ampere types and, as a family, they offer a collector voltage range from 40 to 100 volts. Each is characterized by uniformly low saturation resistance and high gain at high current levels. Normalizing insures their fine performance and uniformity regardless of age. Also important—all Delco transistors are in volume production and readily available at moderate cost.

For complete data contact us at Kokomo, Indiana or at one of our conveniently located offices in Newark, New Jersey or Santa Monica, California. Engineering and application assistance is yours for the asking.

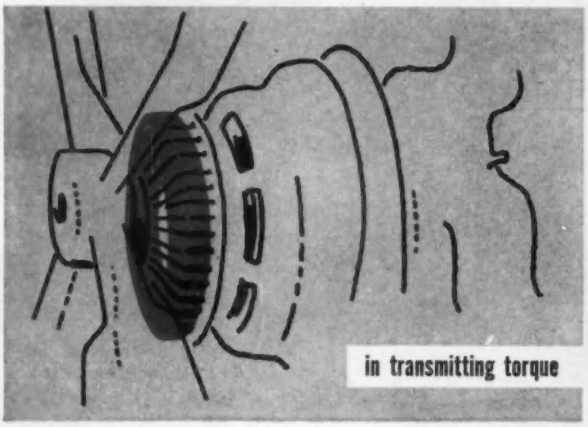
DELCO RADIO DIVISION OF GENERAL MOTORS, KOKOMO, INDIANA



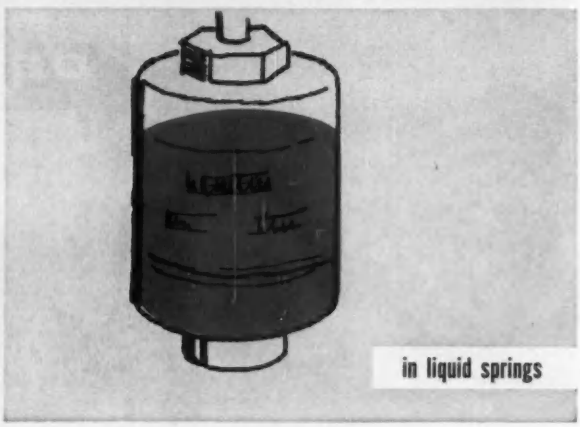
in torsional vibration dampers



in damping delicate instruments



in transmitting torque



in liquid springs

Silicone Fluids ASSURE UNIFORM PERFORMANCE DESPITE HEAT OR COLD

Dow Corning silicone fluids retain near-constant viscosity over a wide temperature span. Their effectiveness as damping media or coupling fluids is unimpaired by heat or cold . . . also true of their use in liquid springs. Silicone fluids are already helping automotive designers get better performance in such parts as those shown . . . future uses are almost limitless. Consider the unusual properties of these materials:

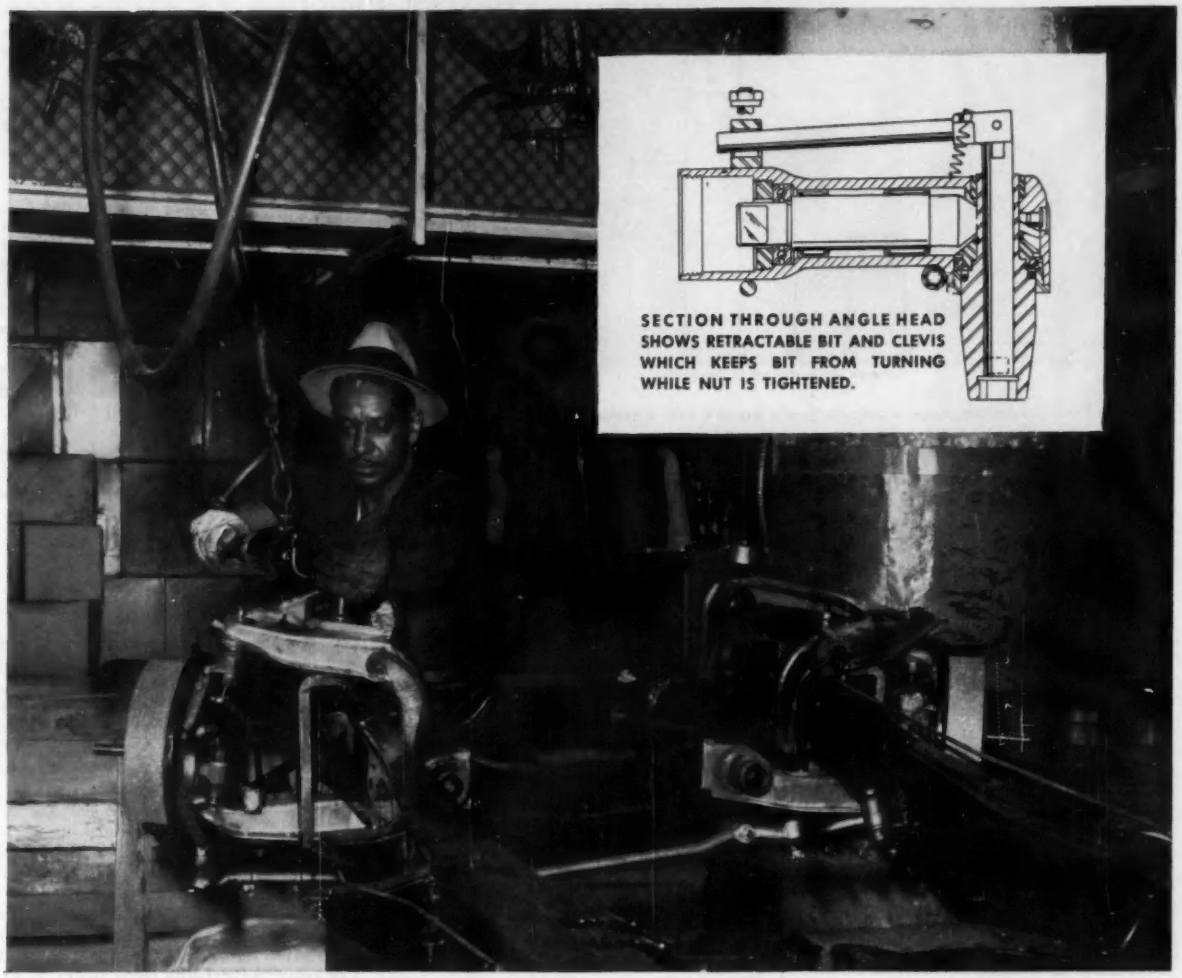
FOR DAMPING OR COUPLING Dow Corning silicone fluids offer serviceability from —130 to 400 F. Available in many viscosities, they show little change in damping or torque transmitting properties despite varying temperatures. These fluids are highly resistant to oxidation and to viscosity breakdown due to shear. As a result, they give very long service without replacement.

FOR LIQUID SPRINGS Dow Corning silicone fluids combine a high degree of compressibility, low coefficient of expansion, and flat viscosity-temperature slope.

WRITE TODAY FOR MORE EXTENSIVE INFORMATION
DEPT. 912

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN



SECTION THROUGH ANGLE HEAD SHOWS RETRACTABLE BIT AND CLEVIS WHICH KEEPS BIT FROM TURNING WHILE NUT IS TIGHTENED.

Unusual production line problem solved by specially adapted air tool

This operation is unusual in that the nut must be run down and tightened on the slotted, headless shock absorber adjusting screw *without turning the screw itself*. With the specially adapted Gardner-Denver 16C angle nut setter, a retractable stationary blade (such as a screw driver bit) inside the socket keeps the screw from turning.

Cuts production time

Hand tools are usually employed for this type of operation. However, the versatile angle nut setter easily does the job in a fraction of the time required by hand methods. It also holds torque within commercially required limits.

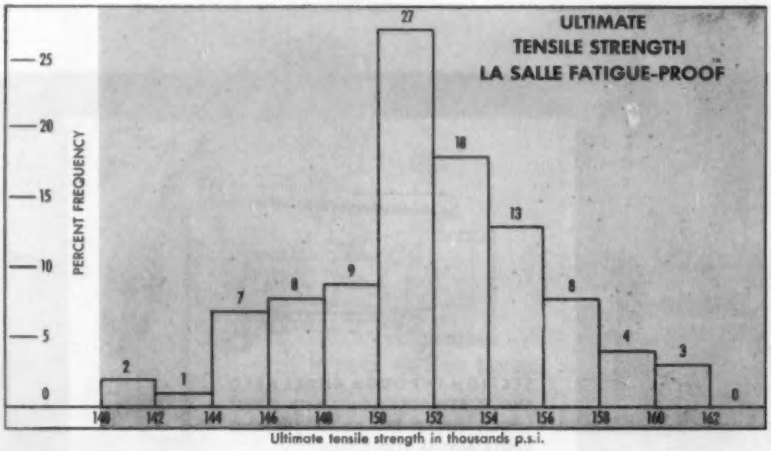
The above example is typical of special problems that Gardner-Denver's Keller tools solve for production men. If a standard tool isn't available for a particular application, Keller specialists will work with your tool engineers on an adaptation to fit the job. Write your Gardner-Denver representative for complete details.

ENGINEERING FORESIGHT—PROVED ON THE JOB
IN GENERAL INDUSTRY, CONSTRUCTION, PETROLEUM AND MINING

GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois

In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Avenue, Toronto 16, Ontario



The above chart shows the range of ultimate tensile strength over a period of one year's production. Average value obtained is approximately 150,000 p.s.i.

"e.t.d."™ Process Applied to FATIGUE-PROOF™ Steel Bars Gives Added Strength, Greater Uniformity, Better Machinability

Guaranteed 140,000 p.s.i. minimum tensile... no heat treating necessary

Six important physical and mechanical properties, (1) a high strength level, (2) exceptional uniformity, (3) improved machinability, (4) wear resistance, (5) resistance to fatigue, and (6) dimensional stability, are desirable features of La Salle "FATIGUE-PROOF" steel bars, produced by the new "e.t.d." (Elevated Temperature Drawing) process.

Strength . . . "FATIGUE-PROOF" is a carbon steel bar which replaces both hot-rolled or cold-finished carbon and alloy heat-treatable steel bars. Production figures show hardnesses between Rc 30 and Rc 36 (with a minimum hardness guarantee of Rc 30). The guaranteed minimum tensile strength is 140,000 p.s.i. with a 150,000 p.s.i. average.
"FATIGUE-PROOF" is better than a heat treated bar because it is not quenched and tempered and so the problems frequently associated with quenching and tempering such as (1) quench cracks, (2) non-uniformity of section, (3) soft centers, and (4) heat treat distortion are eliminated. Costly secondary operations such as grinding, cleaning, and straightening are not necessary. Rejects are minimized.

Exceptional uniformity... "FATIGUE-PROOF" is remarkably uniform from bar to bar, end to end, size to size, and lot to lot. Design and production engineers can depend upon it being the same from day to day and job to job.

Individual processing of each bar plus the inherent good qualities and characteristics of the "e.t.d." process account for the excellent uniformity. Microstructures are uniformly pearlitic.

Improved machinability... "FATIGUE-PROOF", made by "e.t.d.", machines 50% to 100% faster than heat treated alloys, and 25% faster than annealed alloy steels. It machines with a very fine finish, and gives excellent tool life. These characteristics make it an ideal steel for production parts.

Wearability . . . Field applications such as gears, pinions, pins, and screws prove that "FATIGUE-PROOF" has good wear resistance. It resists galling and seizure, partly due to its hardness . . . and probably due to the anti-weld characteristics of its chemistry. Further, "FATIGUE-PROOF's" pearlitic structure appears to resist sliding wear better than a quenched and tempered structure of equal hardness.

Resistance to fatigue . . . The chief reason for the failure of highly stressed parts is fatigue. While part shape, unfavorable residual stresses, tool marks, gouges in highly stressed areas, and many other factors contribute to fatigue failure, most materials have also an inherent quality . . . endurance limit that is an indication of ability to resist fatigue.
"FATIGUE-PROOF" has this inherent quality to resist fatigue. Laboratory tests prove that fatigue properties are at least comparable to those of expensive heat treated steels of the same strength level. Numerous field tests, under severe operating conditions, have proved this to the satisfaction of many manufacturers.

Dimensional stability... "FATIGUE-PROOF" maintains a high degree of dimensional stability in machining because of its low order of residual stresses.

Details of the e.t.d.™ process . . . Elevated Temperature Drawing involves (1) the selection of bar chemistry, (2) the amount of reduction in cross-sectional area of the bar as it is drawn through a special die, and (3) a preselected elevated drawing temperature which will result in the desired final properties.

Although the "e.t.d." process was first announced early in 1957, it has been used in the production of "FATIGUE-PROOF" steel bars since September 1955. Four U.S. Patents (Nos. 2,767,835, -6, -7, and -8) were granted October 23, 1956, covering the "e.t.d." process – an exclusive development of La Salle Steel Company.

How manufacturers can obtain sample Fatigue-Proof steel bars for testing

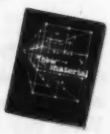
LaSalle Steel Company has announced that samples of "FATIGUE-PROOF" steel bars, made by the "e.t.d." (Elevated Temperature Drawing) process, are available for test purposes on a no charge basis to manufacturers where it appears that "FATIGUE-PROOF" can help improve products and reduce production costs.

Applications for a sample bar are invited from manufacturers making parts from either hot-rolled or cold-finished carbon or alloy steel bars which require high tensile strength.

Interested manufacturers may write for a test sample by sending a blueprint or application details direct to LaSalle Steel Company, Advertising Department, P. O. Box 6800-A, Chicago 80, Ill.

"FATIGUE-PROOF" is also available from your steel distributor . . . write for his name.

Brochure tells story of Fatigue-Proof steel bars



"A New Material" is the title of a 24-page booklet which gives detailed information covering La Salle "FATIGUE-PROOF" steel bars made by the Elevated Temperature Drawing process.

The booklet presents the results of more than one year's tests of production samples and reports on eight application case studies. Copies available on request.

TM—Trademarks of La Salle Steel Company



La Salle STEEL CO.

1458 150th STREET
HAMMOND, INDIANA



A New Basic Material
shaped to your specifications

Lower costs with premixed precision moldings that meet high-production needs

Complex unit assemblies requiring details such as holes, slots, grooves, tapers and bosses are being mass-produced in record time, with record economy, at Woodall Industries Inc.

The secret is in a premixed molding compound . . . *Formadall* . . . a new sisal- or glass-fibre-reinforced material developed and produced at Woodall through *cooperative research* with major automotive manufacturers. Millions of finished parts have been produced, at tremendous savings. You too can prove the advantages of *Formadall*—easily and quickly—through Woodall's unique prototype technique which eliminates costly experimental dies and molds. Let our engineers and chemists know about your particular cost-reduction problems!

FORMADALL FEATURES

Lightweight • Resists corrosion • Low tooling costs Reduced heat transmission • Reduced noise transmission • Resists high temperatures • Adaptable to intricate shapes • Molded in colors • Physical properties adaptable to product requirement.

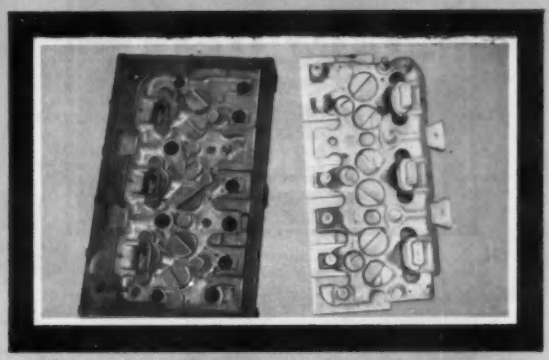
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EPON® RESIN does it!

Speeds up International Harvester's Milwaukee Works' pattern modifications 65% ...cuts costs 50%!



Minimizes costs of design changes—International Harvester saved $2000 by making design modifications on an Epon resin model (right) of original drag jacket corebox (left).



Both model and mold are produced from an Epon resin-glass cloth laminate made for International Harvester's Milwaukee Works by Kish Industries, Inc., Lansing, Michigan.



Epon Resin simplifies pattern production—Epon resin faced cope and drag patterns for an IH engine can be drawn from molds with little danger of sticking.

Here's how:

AT INTERNATIONAL HARVESTER CO., world-famous manufacturers of farm equipment, Epon resins have created a money-saving revolution in foundry pattern modification.

For example: to enlarge the cross section of a frame casting for an IH crawler tractor, a pattern change would normally require 3 weeks and cost $700. *But by applying Epon resin . . . costs dropped to $300 . . . and the pattern was back in production in 1 week!*

In another situation, the use of Epon resin to make a plastic core model of a new drag jacket corebox from the old one saved IH over $2000.

In many fields of industry, the Epon resins are making such savings possible because they have ideal properties for tooling applications:

- Exceptional dimensional stability . . . high impact strength . . . excellent resistance to abrasion . . . minimum residual stress in cured parts.
- Ease and speed of preparation.
- Low shrinkage in filled formulations, assuring perfect master reproductions; minimum warping and stresses.
- Adaptability to repairs and design changes.
- Minimum finishing requirements for smooth surfaces.

Can Epon resin tools and dies make comparable improvements and savings in *your* operations? Find out now by writing your tooling resin formulator.

SHELL CHEMICAL CORPORATION

CHEMICAL SALES DIVISION, 380 Madison Avenue, New York 17, New York

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THIS IS GLASS

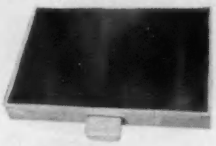
a bulletin of practical new ideas  *from Corning*

The long and the short of it ... a primer on optimum heating methods

Take a white-colored object and place it near an infrared lamp with a Kelvin rating of 2500°. Some *30%* of the radiant energy will be absorbed.

Next take an ordinary sheathed wire unit at 1000°K. The same object will absorb *70%* of the measurable output.

Now take a new PYREX® industrial radiant heating panel. It looks like this.



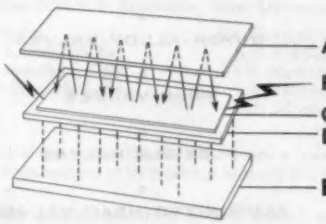
It operates at 600°K. and your white object will now absorb *90%* of the radiant energy.

Behind these differences lies the question of *wave length* emitted by each source. Infrared lamps peak at 1.2 microns; a sheathed unit like the one described hits 3. But the PYREX heater gives from 5 to 20 microns.

It's the *longer* wave lengths that make the difference. And *more* absorption means *more* effective heating per unit of energy expended.

These wave lengths offer you two distinct advantages: (1) all colors will absorb nearly the same amount of them —this means even heating regardless of color and (2) all colors will absorb these waves much more readily than they will the short wave lengths of lamps or sheath wires. With white colors, the absorption is greater with panels than lamps by a factor of nearly 4 to 1.

PYREX industrial radiant heaters have as their heart a panel of tempered *glass* that has a fused-in coating of thin conducting film. The panel is mounted in an aluminized steel frame. A self-contained unit, each heater comes with built-in aluminized steel reflector, mounting hangers, junction box and leads.



A. Reflector—aluminized steel
B. Electric current
C. Resistance element—conductive film
D. Heating element—tempered glass
E. Work—*all* materials except metallic reflectors

Because it's tempered the glass panel is *rugged;* it also is extremely corrosion resistant. Maintenance is a negligible factor since occasional dusting with a dry cloth is sufficient. If needed, heaters can be cleaned when cold by rubbing gently with a soft rag lightly dampened with alcohol.

PYREX radiant heating panels come in 8 different models, the smallest $11\frac{5}{8}''$ square, the largest $23\frac{5}{8}''$ square. (Note: rectangles are included in this selection.)

Watts per square inch go from 5.4 to 9.5 and the element itself (when measured in ambient air at 70°F.) runs from 550°F. to 660°F.

Heaters can be mounted horizontally, above *or* below work; vertical installations also possible and practical.

The heat you get from such units is *uniform* (because it's an *area* source) and *effective* (because of its *long* wave).

PYREX radiant heaters look like a real "hot" answer for drying, baking, curing, preheating—just about any application where you want to put the *heat* on and get the most for your investment in space and kilowatts.

Bulletin PE-60 gives the salient data on construction, installation, ventilation, wiring and controls, and maintenance. There's also a full story on where to get and how to use the Corning "Process Prover"—a "pilot" setup complete with percentage timer, pyrometer, variable table and such. PE-60 is free. Using the coupon facilitates matters.

15 gets you 75

Somebody in one of our offices has figured out that 75% of the products we now make were *not* in production 15 years ago. Which means? Glass (as engineered by Corning) is appearing in ever-increasingly useful forms.

Take a few minutes to glance through "This Is Glass" for a sprightly review of this growth. Or brief your problem and let us see if we can't come up with a *glass* answer.



Rounding out the line

Possibility: Some day the writing tip of your ball point pen may be made of glass. *Certainty:* In sizes somewhat larger than those useful for such a purpose, glass balls are available *now* and in *quantity.*

Before final grinding and polishing they look like this.



Since a number of other materials have long been available in sphere form, this news may not appear so startling.

Still a number of considerations that may interest you are involved. First—*Continuous* production of *optical* quality glass was accomplished—no mean feat. Then, Corning developed a *new,* high-speed machine for forming small diameter glass balls.

With this machine now in operation, the following specifications pertain:

Basic data on glass balls

Diameter range	.133″ min.
	.425″ max.
Diameter tolerance .	±.012″
Sphericity of ball within	.008″

What can you do with bits of glass like this? So far interest has been evidenced for using them in finger tip spray dispensers, for hand lotions and cosmetics, valves for blood transfusion and oxygen equipment, and hydrolytic controls.

Corrosion resistant, small, noncontaminating, nonmagnetic, capable of taking a fine finish—glass balls await your evaluation.

Inquiries marked for Railroad and Industrial Sales will get fast action.

Corning means research in Glass

CORNING GLASS WORKS, 40-2 Crystal Street, Corning, N. Y.

Please send me the following: Bulletin PE-60 "PYREX® Brand Industrial Radiant Heater" ☐; "This Is Glass" ☐.

Name _____ Title _____

Company _____

Street _____

City _____ Zone _____ State _____

Eaton Valves are Solving Problems Like These—



1. Broken valve due to overstressing.

2. Corrosion and cracking of the valve face caused by leakage.





3. Corrosion of the valve face due to sticking caused by stem and guide deposits.

4. Actual melting of valve material due to extremely high temperatures caused by preignition.



If you are having valve troubles, why not discuss them with Eaton Valve Division engineers. They will be glad to work with you in diagnosing the causes of failure, and in developing valves to meet the particular requirements of your engines and the kind of operation in which they are used. In hundreds of cases, Eaton engineers have been successful in suggesting measures which have corrected the most stubborn valve train problems. A study of your problem with complete technical report involves no obligation.

Write, wire, or phone.

SODIUM-COOLED VALVES

•

SUPER-ALLOY VALVES

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FREE-VALVES

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FLEXIBLE VALVES

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ALUMINIZED-HEAD VALVES

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MANUFACTURING COMPANY

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For the Sake of Argument

One Is All . . .

By Norman G. Shidle

The aims, ideals, and achievements of any group accrue from the aims, ideals, and achievements of individuals. "Man cannot be raised in a mass. The work must be effected through the individual. Then success is assured," is the way Frances Mack Mann puts it.

The State may be able to produce any given number of technicians. But it can increase the number of creative scientists only by development of an environment in which creative thinking by individuals will thrive. Commenting on a book by William Ernest Hocking (Harvard's emeritus philosopher), Dorothy Thompson points out:

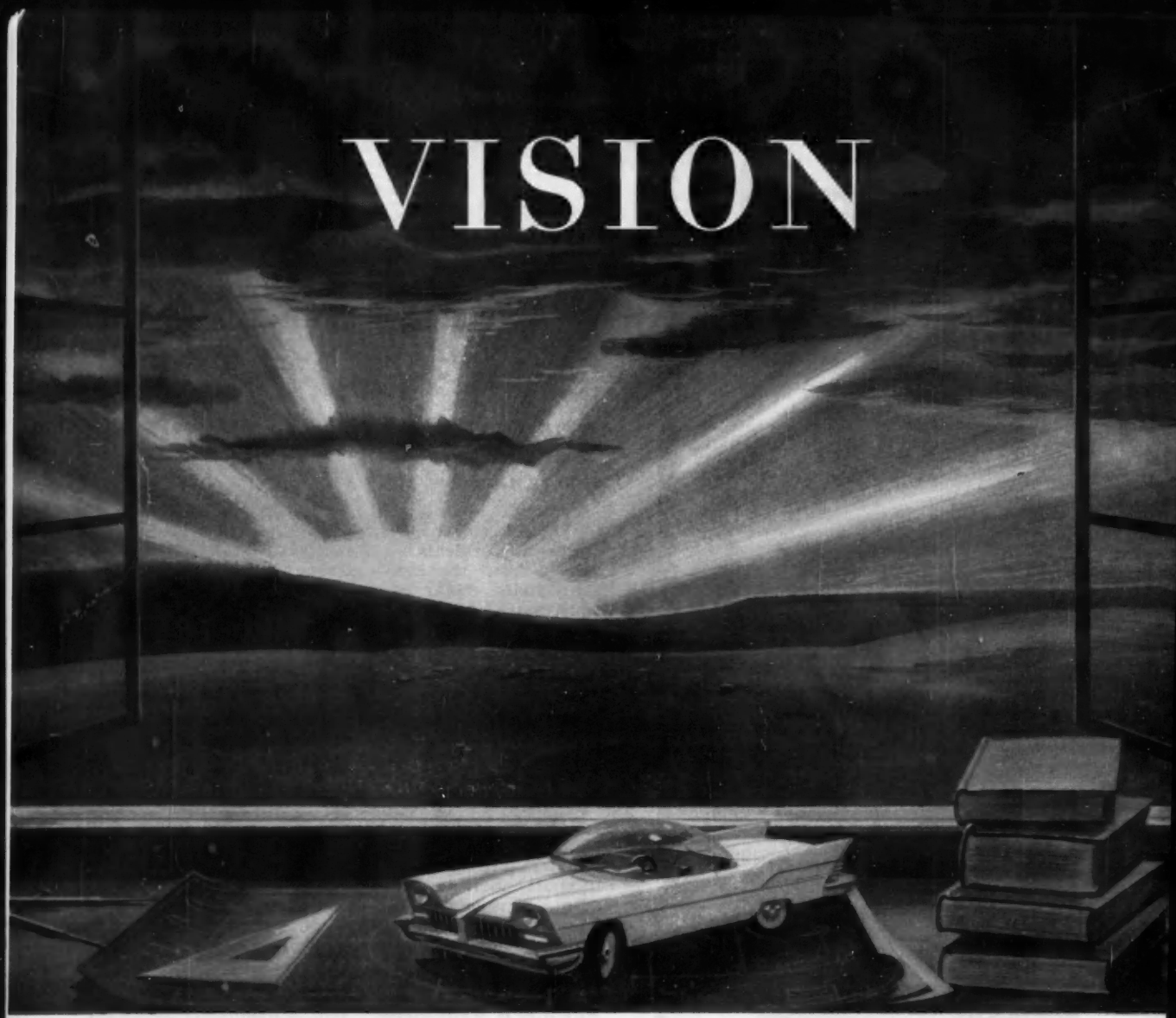
"The State cannot by itself mold the minds and volitional wills of children and youth. It can only hire teachers. It cannot re-create anyone. . . . It depends, in short, upon forces outside its command. It cannot create conscience—in the individual or society—and thus cannot, of itself, supply the life force on which it depends."

In practice, hi-fidelity broadcasting is only as faithful as the limits of each of the receiving sets through which it is transmitted. The individual remains the unit in which growth, understanding, and progress takes place. It is from the individual's struggle for understanding of himself and his environment that group movement unfolds.

Only a few months ago, Dr. Lawrence Hafstad emphasized that: "Progress cannot be made without struggle, nor freedom enjoyed without individual responsibility." His statement echoes that of Woodrow Wilson: "Liberty belongs to the individual or it does not exist. . . . The individual is the first fact of liberty. . . . There can be no corporate liberty."

Each of us contributes to group progress as we search for meanings along with facts; for understanding along with knowledge. Each of us contributes to the extent that he manages to recognize and live what Edward B. Newill calls a basic truth:

"Success in life is not a destination. It is a journey."



LOOKING TO THE FUTURE—PRODUCING FOR TODAY!

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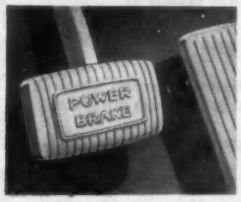
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TYPICAL EXAMPLES



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Bendix PRODUCTS DIVISION **South Bend,** IND.

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SAE ANNUAL MEETING

THE 1958 SAE Annual Meeting, Jan. 13–17, was devoted primarily to development of technical data and ideas which will strengthen the United States on the economic front. Much of the engineering progress displayed is applicable to military as well as civilian units. But its chief contribution to defense will be through the better products and methods which help to impede inflationary spirals.

In the corridors of the Sheraton-Cadillac and the Statler, there was still concern with space for passengers and adequate brakes in tomorrow's passenger cars as well as with Sputniks and space ships for interplanetary flight. New manufacturing techniques from Europe were detailed with an eye to their immediate application to automotive and aeronautic products not at all unlike those in which we ride today. The engines designed by computers—which got much interest early in the meeting—were free-piston types unrelated to probable powerplants of the first rockets to reach the moon.

. . . Which is not to say that there weren't plenty of informal discussions of the exciting combinations of engineering and science which continued in the newspaper headlines as the meeting went on. There were. But the intensity and care with which current automotive engineering problems were discussed proclaimed these bread-and-butter items as continuing to be of

Continued on page 73

New automatic transmissions are outstanding features of . . .

1958 European Automobile

Written especially for SAE Journal, this article is an interpretive analysis of current European design trends by an SAE member who has followed those trends closely for many years.

by **Aubrey Pershouse,**

General Motors Overseas Operations

Recent European Shows

The 1957 motor show season in Europe was a particularly prolific one, at least as far as the number of shows was concerned.

Between September 19 and November 10, the biennial Frankfurt show and the annual Paris, London, and Turin shows all took place, in that order. It may be noted that the Italian show has in the past normally been held in the early spring of each year.

Important New Models

While various commercially important new and revised models, such as the very small Fiat 500, the new Vauxhall Victor models, the Austin A55, and face-lifted Hillman had made their appearance earlier in 1957, the number of basically new models appearing at all these shows was not large. In fact, apart from the Fiat 1200 cars, largely employing existing Fiat components, which were seen at Turin, it may be said that the Vauxhall Velox and Cresta models at Paris and London were about the only volume production cars of entirely new design which approach normal car size.

The trend toward production by many firms of rather well-designed station wagons continues. The new Morris Oxford Traveller, Humber Hawk, restyled Opel Caravan, and latest Hillman Minx wagon are examples of this.

Trends in Ultrasmall Cars

The comparatively new breed of sub- or cycle-cars appears to be gaining rapidly in popularity in many European markets. Amongst new makes of this character must be noted the important Fiat 500 model; the German NSU Prinz, the attractive, Italian-designed, but French-manufactured, Vespa; the Italian Bianchina, which uses Fiat 500 components and marks re-entry into the passenger-car field by the well-known Bianchi firm; and the English Frisky, sponsored by the Meadows engine group.

In addition to these brand-new makes of miniature cars, manufacturers of existing successful cars of this kind were seen to have employed many new features. In a great many cases, also, they exhibited greatly improved, more complicated, and larger models at correspondingly higher prices.

Arising from this, a trend may be identified in this segment of European car production—away from the very small single-cylinder, 250- to 350-cc 2-strokes in extremely simple settings, which characterized many of these makes when they started production. This new trend is to larger, multi-cylinder, 4-stroke engines; improved styling; and greater complication, such as that exemplified by the provision of a 4-speed synchromesh gearbox now offered by the German Lloyd. (Lloyd has also abandoned the range of 2-stroke engines used up to this time.)

Goggomobil offers a wider range of more attractively styled cars, including a 600-cc 4-stroke-engined model with wrap-around windshield.

BMW continues its successful, single-cylinder Isetta, which has a very narrow rear track, but

Trends

adds a new 585-cc, 2-cylinder, 4-stroke 600 model with normal, 4-wheel layout, two doors instead of one, and very much better appearance and performance.

Automatic Transmissions —Outstanding Feature

Most outstanding technical feature of the 1957 European shows was the continuing and increasing use of automatic transmissions. There are also many half-way steps toward automatic transmissions, in the form of automatic clutches, by European car makers. The 1956 European shows, and particularly the 1956 London show emphasized the already marked trend in Europe in this direction. In 1957 further automatic transmissions appeared, either in the development stage or actually in production cars.

Also, there is a growing use of automatic clutches of the magnetic and centrifugal type. Use of these devices started some years ago when the French Gravina (centrifugal with electromagnetic control) and Ferlec (magnetic) clutches led the way toward their wider use. At the Earl's Court show in 1956, the Newton centrifugal clutch was shown on small cars in the Standard range; and Manumatic centrifugal vacuum-operated clutches appeared on a wide variety of English cars. In that same year, production of the Borg-Warner automatic transmission in England made possible for the first time an option of this nature on a wider range of the larger and more expensive English cars.

German cars may be said to have lagged behind other European sources up to this point in provision of automatic clutch and overdrive options. However, the appearance at Frankfurt in 1957 of the Saxomat clutch made by Fichtel and Sachs, both on DKW and on the new Ford Taunus 15M and 17M, and of Mercedes' own more complicated and costly Hydrak clutch, coupled with advertising by Zahnradfabrik of a pushbutton transmission with automatic clutch and installation of the Adler overdrive on several German cars including Opel Kapitan, would seem to indicate a rapid move by the German industry toward use of these devices.

New Users of Automatic Clutches and Transmissions

At Paris this year Peugeot and Panhard added the Jaeger magnetic-particle automatic clutch as an option. This is the Smith Selectroshift made under license and marks the first appearance of this device, which has been under development for some years in England, in production use. In addition, Renault showed an automatic transmission, which they call the Transfluide, on their 2141-cc (131 cu in.) Fregate car. In London the Newton clutch, in improved form, appeared for the first time as optional equipment on English Ford Anglia and Prefect cars, with Hillman quoting Manumatic for their line.

This year the British-made Borg-Warner automatic transmission was made an option on the Standard Vanguard cars of only 2008-cc (128 cu in.) displacement. This is interesting as being the smallest engine with which this well-known transmission has so far been coupled. The Isetta cyclecar, still being made in England in its original narrow-track form, announced use of the English Smith's magnetic-particle Selectroshift automatic clutch; and the Rover firm continues its own torque converter transmission, introduced a year ago. The British Motor Industry Research Association (MIRA) showed an automatic transmission at the Earl's Court show, which they are developing especially for use in cars with small displacement engines. Further description of this drive is given later.

While space considerations preclude giving details of all the foregoing automatic clutch and transmission devices, many of which were not new at the 1957 shows, some further discussion of selected new items should be of interest.

First Use of Automatic Clutches on German Cars

Several German cars fitted with Saxomat and Hydrak automatic clutches were driven by the writer. These devices may be said to provide a perfectly practical and satisfactory method of gear changing, to which one rapidly becomes accustomed. The same is true of several of the English arrangements of this nature.

The Saxomat (Figs. 1 and 2) uses centrifugal force to control the clutch between stop and forward movement and electrically operated vacuum servo power to permit gear changes while the vehicle is in motion. It has a locking mechanism to permit emergency pushstarting. The Hydrak (Figs. 3 and 4) is considerably more elaborate than the Saxomat, as it includes a fluid flywheel, a mechanical clutch with booster unit, and special controls

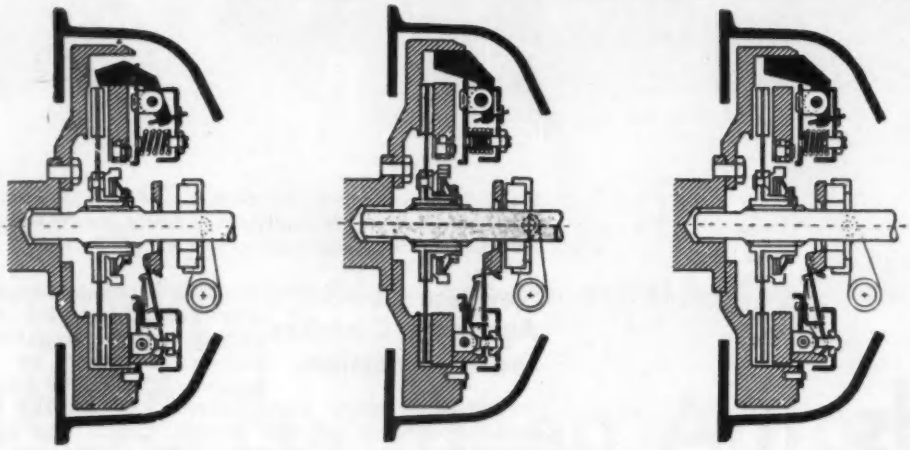


Fig. 1—Section of Saxomat automatic clutch.

Left - Engine idling, clutch disengaged by withdrawal springs - Bob weights idle.
Center - Clutch engaged for driving - Bob weights are locked to inner circumference flywheel.
Right - As gear change is made bob weights remain locked to flywheel, clutch is withdrawn by vacuum-servo action.

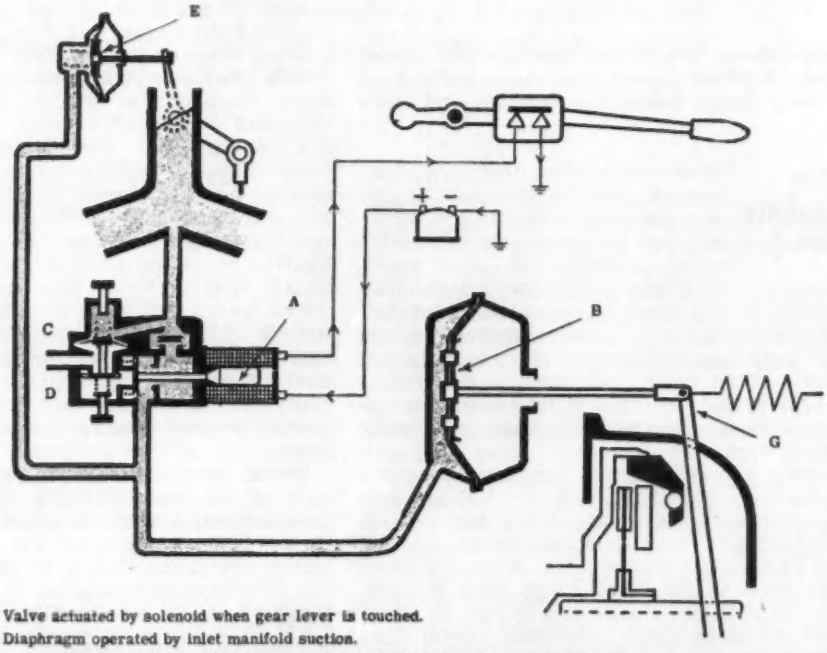


Fig. 2—Components of Saxomat automatic clutch.

A = Valve actuated by solenoid when gear lever is touched.
B = Diaphragm operated by inlet manifold suction.
C, D = Valves which regulate speed of return of atmospheric pressure related to throttle opening after completing gear change.
E = Throttle control to maintain engine speed above centrifugal clutch disengagement speed during gear changes.
F = Gear lever
G = Clutch withdrawal rod.

for this. Hydrak also employs some components made by Fichtel and Sachs.

Renault Automatic Transmission

The Renault Transfluide transmission already referred to consists of a torque converter backed by a single-plate, Ferlec-type electromagnetic, automatic clutch, which in turn is followed by a synchromesh gearbox, having three forward speeds and manual shift on the steering column. (See Fig. 5.) It is unique in using engine lubrication oil as the transmission fluid. Both transmission and clutch have been beefed up to withstand torque multiplication by the converter, amounting to a maximum of 2.3/1, while to compensate to some extent for converter power losses, engine compression has been raised from 7/1 to 7.5/1 and output from 77 to 80.3 bhp, at 4000 rpm.

This Renault arrangement is similar to that

which Rover introduced in 1956. In the case of Rover, however, one automatic shift up and down is obtained in the drive-range by the use of a Laycock de Normanville overdrive (as fitted to many English cars); but the Renault layout provides a fixed drive-range only. Second gear is intended for mountain driving and overtaking on grades, while first is a purely emergency ratio. For all normal driving, including acceleration from a standstill, it is the intention that drive-range only be employed without recourse to manual gear changes.

Under these circumstances, and in view of the limited engine size of the Fregate 2141 cc (131 cu. in.), a test drive of 15–20 miles on the outskirts of Paris, including a return on the Auto Route de l'Ouest was of considerable interest. Driving and riding in this car showed the Transfluide to be silent, smooth, and progressive in operation; but, as might be expected, the driver is left with an impression that acceleration in the drive-range from low engine speeds, or on even a moderate upgrade, while steady, is not fast. The combination of the Transfluide with this Renault would probably be perfectly acceptable to an undemanding driver or to one not accustomed to operation of a large-engine, automatic-transmission vehicle.

MIRA Automatic Transmission

While it is not the function in the U. S. of a body such as MIRA to undertake cooperative design and development work for the industry, this is one of the functions normally carried out by MIRA; and they are developing an experimental transmission, which was shown at Earl's Court in prototype form and which, following satisfactory bench tests, is now being-road-tested with an engine of some 2000 cc (122 cu in.) displacement and some 50-bhp output. (See Fig. 6.) The device is of considerable interest in view of the fact that it has been designed to make the minimum use of hydraulics so as to obtain reasonable overall efficiency and at the same time retain the best features of hydraulic drives. Thus, it should be potentially more suitable for use with small engines than a scaled-down version of the torque converters now in use with U. S. cars.

As described in the English technical press, the transmission is a novel one, involving use of hydraulic pumps with lower torque capacity than the two simple planetary gearsets, of which the leader provides the overdrive ratio of 0.7/1 and the rear set, the lowest ratio of 3/1.

The mechanical-versus-hydraulic functioning of the device has been likened to an electrical shunt circuit in which the gears represent the fixed resistance and the hydraulic circuit is the variable.

The major share of power is carried through two normal planetary gearsets, while the hydraulic element of the device functions to control the planetary gears and involves a bypass and two pumps, which take the place of the friction brakes nor-

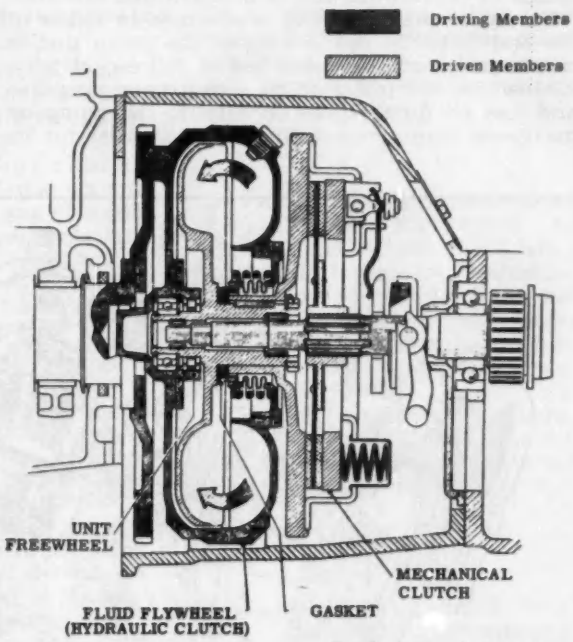


Fig. 3—Longitudinal section of Mercedes Hydrak automatic clutch.

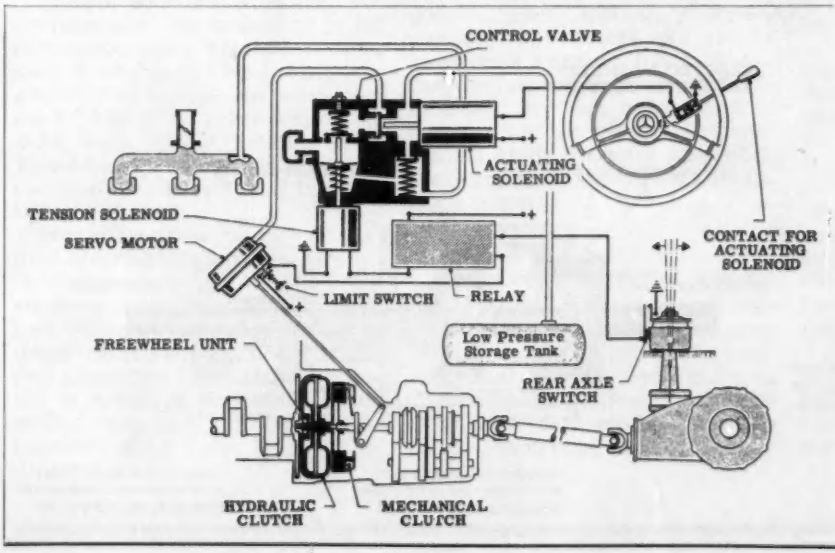


Fig. 4—Hydrak automatic clutch control system (neutral-mechanical clutch engaged.)

mally used to operate planetary gears. Hydraulic fluid is moved in a closed circuit by the two pumps whose variable displacement controls are linked to insure decrease of one pump's displacement as the other's increases. A feature of the device is that when either of the extreme planetary ratios is in use, no power is transmitted by hydraulic means.

Between the above ratios, infinitely variable transmission is obtained by operation of the two variable dispacement hydraulic pumps of the eccentric vane type. Variable eccentricity of the pump vanes adjusts their fluid displacement per revolution. The pumps are mechanically locked, by means of hollow shafts, to the gears—one pump to the sun gear in one set and the other to the annulus of the other gearset. A valve, responsive to engine speed and throttle opening, regulates the hydraulic drive while this is in operation.

Purely mechanical drive is obtained in either of the end ratios by the locking of the pump that is on maximum displacement and at full eccentricity. Meanwhile, the pump at nil eccentricity runs free and has no fluid intake or output; the pump on maximum displacement thus has no outlet for its fluid and is thereby restrained from rotation. Intermediate ratios are obtained as the relative speed of the two pumps' rotation varies. At no time does the hydraulic system transmit more than 35% of engine output.

A reverse gear is provided by means of positive engagement with a third gearset located behind the first two. It is stated that no separate clutch will be necessary for use with the MIRA transmission, as releasing pressure in the hydraulic circuit will provide a clutch-disengaged effect which will be eliminated by gradual closing of the release valve.

There have been several attempts in the past to match automatic transmissions to small European engines, of which the Hobbs, recently offered on Lanchester, is an example. The MIRA design would seem to have better chances of success than some of its predecessors.

The sponsors claim that, on the basis of cost, weight, and fuel economy, the MIRA transmission should be comparable with a normal 4-speed synchromesh transmission; in fact, the further claim is made that because of its very smooth operation, some improvement in fuel economy may result.

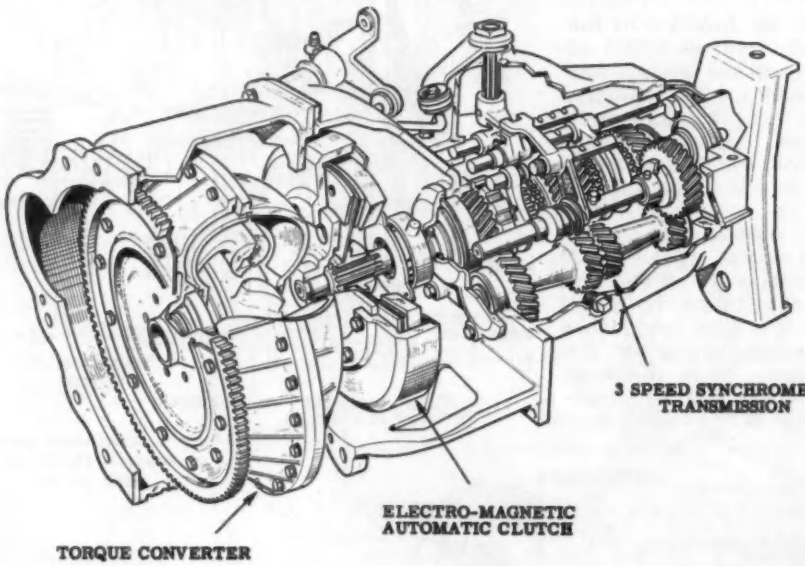


Fig. 5—Overall view of Renault Transfluide automatic transmission.

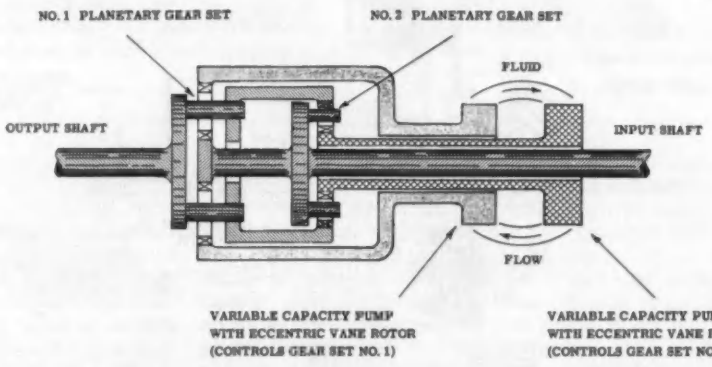


Fig. 6—MIRA experimental transmission — diagram of planetary gear and hydraulic circuit hookup.

chips

from SAE meetings, members, and committees

HAVE YOU CAUGHT UP with the fact that it's "niobium" now for the once-scarce element that used to be known in this country as "columbium"?

Well, not everyone has. A speaker at Annual Meeting told about a salesman for alloy steels who called to tell his client that a certain precipitation hardening steel is being made with niobium now instead of columbium. The client's metallurgists put tongue in cheek and asked why the switch was made. It doesn't really make much difference in the product, the salesman admitted, but columbium was scarce and niobium is plentiful.

•

SOME 200,000 CARS WERE IMPORTED into the United States last year—more than twice as many as in '56. . . . And well over 80% of these imports nowadays are small "economy" models. Sharpness of the upswing is emphasized by looking back only as far as '54, when the import total was only 32,403 cars . . . and to '55's total of 58,460.

The upswing in imports to 98,187 in '56 took place while U. S. sales were declining by 17% . . . and the doubling of foreign car sales here from '56 to '57 occurred while U. S. sales were barely holding even. These foreign "economy" cars represented well over 3% of U. S. '57 sales.

Reporting these figures at Annual Meeting as providing "an interesting challenge to American engineers," *Fortune's* Robert Sheehan wished the best of luck "to those American engineers whose new assignment may be, in a manner of speaking, to see how many angels they can engrave on the head of a pin."

LIMIT IN CARBURIZING TEMPERATURES, at present, appears to be about 1750 F. Production materials have been carburized at this temperature, in both rotary and pit furnaces, with the following results:

1. Carburizing cycle time is reduced by as much as 30% when compared with carburization at 1700 F.
2. There has been no discernible difference found upon alloy fixture life, and distortion of production parts, as compared to 1700 F operation.
3. Case depths as low as 0.04 in. and up to 0.120 in. have been achieved with surface carbon usually held to 0.91–1.10%.

Carbon concentration, of course, will be influenced by materials, type and condition of furnace, carbon potential—just as these factors are influential at 1700 F.

Since 1750 F approaches the coarsening temperature for at least a substantial percentage of some heats of steel in many steel grades, the following practice seems to prevail: carburize, direct quench, reheat, quench, wash, and temper. The reheat and quench operations improve the core and the case, especially if any parts are mixed in the lot which tend to coarsen. Some plants, however, control their material quality to the point that only direct quenching is required.

•

A CAST-ALUMINUM BRAKE DRUM with cast-iron segments bolted into the inner surface as a liner has been developed—but has not been made in production quantities. One heavy-duty truck user reports good life from such drums, and a weight of 70 lb as compared to 110 lb for cast-iron drums of equal serviceability . . . but says they are quite expensive.

Another development—not yet tried with heavy-duty truck brakes—is use of sprayed metal on the inside surface of the aluminum drum to provide the wearing surface.

•

CARBURIZING TECHNIQUES AT TEMPERATURES AS HIGH AS 2100 F are being tried in the laboratory. Industrial production has tried 1800 F, but with not too much success. Some companies are carburizing production materials at 1750 F, however, with no ill effects.

Carburizing at higher temperatures provides greater penetration in a given time or shorter cycles for a given depth of penetration.

•

A FLEET having 90,000 vehicles (which is approximately the magnitude of AT&T's operation) would just about begin to justify the use of a computer for study of motor vehicle operations. That's the conclusion of the Investigating Subcommittee for Computers of SAE's Transportation and Maintenance Activity.

In investigating the feasibility of using computers to study motor vehicle operations, the Submittee found that an adequate computer would involve a rental fee of approximately $400,000 per year. Installation of the computer would require an initial cost of about $200,000. Considering these costs, it is estimated that computer operation would run about $600 per hr.

New Extrusion–Fabrication Reduces

Based on paper by

Neil J. Feola

Curtiss-Wright Corp.

THE high strength-to-weight ratio of titanium and titanium alloys offers a considerable weight advantage in aircraft applications as a lightweight replacement for mildly stressed and corrosion-resistant steels.

Full utilization of this weight advantage, however, has been hindered by the high cost of finished titanium parts. In fact, using conventional steel manufacturing methods, the cost of titanium parts has been as much as ten times greater than the cost of steel counterparts.

This high premium reflects the basically high cost of raw titanium material and the conventional manufacturing methods employed to transform this raw material into finished parts.

The use of conventional manufacturing methods generally results in a low ratio of finished part weight to raw material weight. While this situation is tolerable for relatively low cost steel, applied to titanium it results in considerable cost due to the loss of expensive raw material in the form of unreclaimed scrap.

The Curtiss-Wright Corp., under contract from the Air Material Command of the USAF recently developed a production manufacturing method capable of reducing finished part costs and with correspondingly high material utilization. This newly developed method, which is described in this article, utilizes the extrusion process as the primary metal-working operation.

CURTISS-WRIGHT has developed a process of making ring-shaped titanium jet engine parts by extruding a suitable cross-section in strip form, cutting the strip, bending into a circle, and welding together the ends.

To demonstrate the process, typical titanium annular rings in unalloyed titanium (A70) and in the 5Al-2½Sn (A110AT) titanium alloy were manufactured (Fig. 1). In an engine, these rings represent end flanges for sheet metal assemblies. Manufacture of these flanges by conventional techniques, such as forging or from wrapped and welded barstock, results in grossly oversized sections.

By the newly developed extrusion method these rings were manufactured as follows:

1. **The basic cross-section of the rings was extruded in straight lengths with a minimum machining envelope.**
2. **The extruded lengths were contour formed into 360 deg rings and flash-butt welded.**
3. **The rings were sized and finish-machined to dimensions.**

Using this new technique, only one-half of the raw material required by conventional methods was needed to manufacture the finished part. An additional increment of cost savings resulted from extruding these sections directly from cast ingots rather than from forged billets.

Extrusion

Since the extrusion process represents the key to the manufacturing method, the major portion of the development activities were focused on this operation. Studies were conducted on the 12,000 ton horizontal extrusion press located at Metals Processing Div. of Curtiss-Wright in Buffalo (Fig. 2). This facility is equipped with containers which will per-

Process Jet Engine Parts Costs

mit the extrusion of stock ranging in diameter from 8 to 24 in. Corresponding to these various diameter containers are stages supplying 4000, 8000, and 12,000 tons of force. For the flanged ring application, the 4000 ton stage and the 8 in. diameter container were used exclusively.

Heating of the extrusion stock was accomplished by means of a barium chloride salt bath located immediately adjacent to the press.

Rapid transfer of the billet from the furnace to the extrusion chamber was accomplished by an overhead hoist.

A cross sectional view of a typical flange is shown in Fig. 3. In extruding this cross-section, stock was added in the form of a circumscribed envelope (gray area in photograph). This envelope, approximately 0.050 in. thick, not only accounts for the tolerances required for the extrusion operation, but also represents the extra stock required to permit machining to the finished dimensions after rolling, welding, and sizing.

In determining that portion of the envelope required solely by the extrusion operation, a complete study of the extrusion processing variables was performed on round sections. It was desired that this study yield lowest tolerances and maximum extrusion yield. Optimum surface finish resulted from the following combinations of extrusion processing conditions:

	A70	A110AT
Extrusion speed, in. per min	450	450
Lubricant	Fiske No. 630	Fiske No. 630
Container temperature, F	800	800
Die preheat temperature, F	750	750
Die material	Vasco Supreme	Vasco Supreme
Die design, entrance angle-deg	120 to 140	180
Billet heating	salt bath	salt bath
Billet temperature, F	1550	1850

These extrusion conditions resulted in an extruded product for both the A70 and the A110AT materials with the following tolerances:

Nominal Metal Dimensions	Extrusion Tolerance
Less than 1.00 inch	± 0.020 inch
1.00 to 2.00 inch	± 0.030 inch
2.00 to 3.00 inch	± 0.040 inch

This dimensional control can be maintained for lengths of 100 linear feet for the A70 material and 15 linear feet for the A110AT alloy. For the A70 material the 100 linear feet was obtained by five

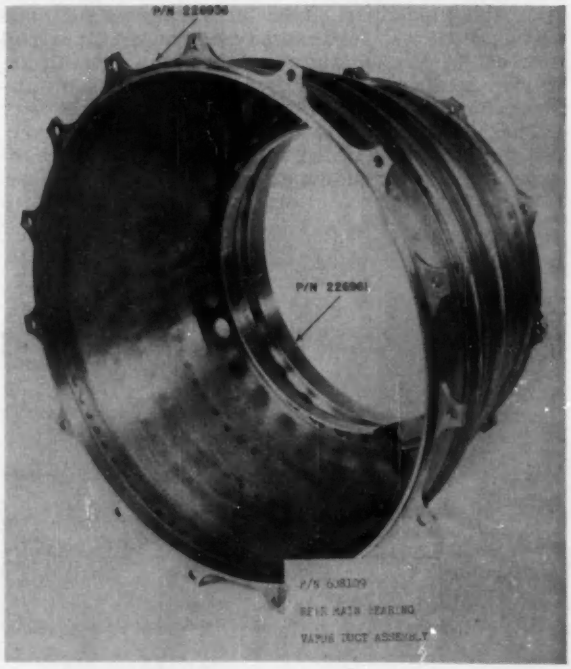


Fig. 1—Titanium annular rings act as end flanges for sheet metal assemblies in jet engines.

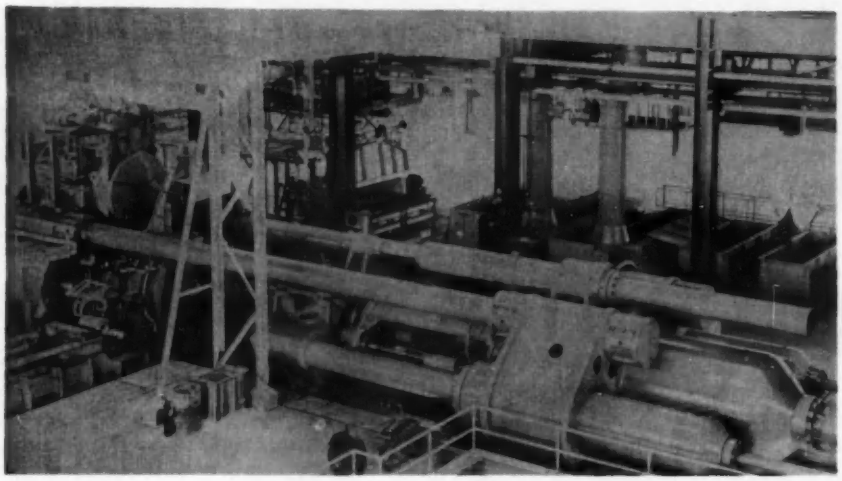


Fig. 2—12,000-ton horizontal extrusion press used for producing titanium jet engine rings.

20-ft extrusions. This length limitation is a direct function of the die wear. Fig. 4 shows several of the dies used after extruding both materials. The condition of these dies clearly points out the reason for shorter lengths in the A110AT extrusion. Undoubtedly, as better die material and lubricants are developed this problem will be surmounted.

Substantial cost savings result from the use of cast ingots for the extrusion stock. Conventional extrusion practice utilizes a billet which has been forged from an ingot to fit a specific container diameter. By extruding directly from a cast ingot both the cost of the forging operation and the material lost in this operation are eliminated. Since this approach pioneered a new technique, considerable development was required to confirm the quality of such extrusions. A study evaluated the effect of extrusion temperatures and extrusion ratios on the mechanical properties of cast ingot extrusions.

The results of this study indicated tensile properties well in excess of the minimum specification requirements by extruding at 1550 F and 1850 F for the A70 and A110AT materials, respectively, for extrusion ratios of 10 to 1 and greater. Typical tensile values for these extrusions are:

	A70	A110AT
Tensile strength, psi	100,000	135,000
0.2% Yield strength, psi	80,000	120,000
Elongation, %	25	20
Reduction in area, %	40	35

For the materials studied, extruding above the beta transus (A70–1625 F; A110AT–1930 F) can result in a severe loss of ductility and subsequent embrittlement. These temperatures, therefore, represent an upper limit. The lower limit for extrusion temperature is established by the pressure requirements. The extrusion temperatures of 1550 F and 1850 F represent a compromise between these limits.

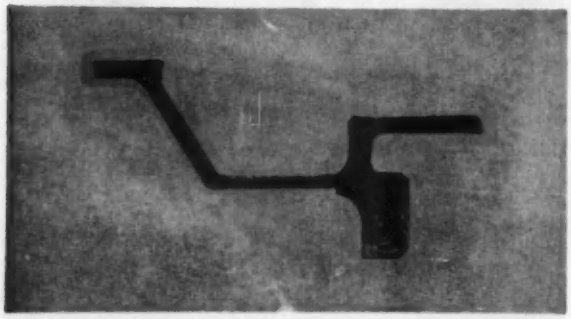


Fig. 3—Extruded flange cross-section indicating the machining envelope.

Contour Forming

The extruded shapes were formed into 360 deg rings on a Bath Radial Draw Former. This machine consists of a power driven circular table and a double-acting pressure-controlled cylinder. Where required, a hydraulic ram, capable of applying a side force to the section being formed, is utilized.

Heating of both the dies and material was required to shape both materials. The temperatures required are:

	A70	A110AT
Material temperature, F	700–1000	1200–1400
Die temperature, F	800	1000

The specific temperature required for any ring depends on the complexity of the cross-section and the ring diameter. As indicated in the above table, however, the temperatures required to form the A110AT rings was found to be generally higher than that required for the A70 material. Forming at too low a temperature results in tearing at the tensile side of the ring.

In all cases, best results were obtained when the

forming operation proceeded as slowly as possible. In addition, a two pass operation, working first with a clockwise rotation of the table and then with a counterclockwise rotation yielded the best results.

Flash-Butt Welding

Welding of the formed titanium rings was performed by two welding sources. The following lists the specifications of the machines used.

	Thomson F-4 Synchromatic	Swift Welder 90KVA
Machine rating, kva	250	600
Maximum clamping force, lb	23,000	160,000
Maximum upset force, lb	32,000	200,000

Initial studies were performed on machined barstock to determine the range of rib ratios (the ratio between thick and thin leg of a complex cross-section) which could be flash-butt welded and as such be capable of meeting the applicable strength and ductility requirements of the specification (AMS 7498). High quality welds were obtained for rib ratios as great as 5.3 to 1. This ratio is considerably larger than that occurring in any of the rings studied.

Sizing

All of the titanium rings were expanded on a 225 ton press brake.

As required by specification AMS 7498, the sizing temperature range of from 700 F to 1250 F was used for both materials. This temperature permitted an expansion of 2% and 1½% for the A70 and A110AT materials, respectively. For small diameter, large cross-section rings, an out-of-round condition resulted from welding. Prior to sizing these rings, a rolling operation was performed to restore the ring

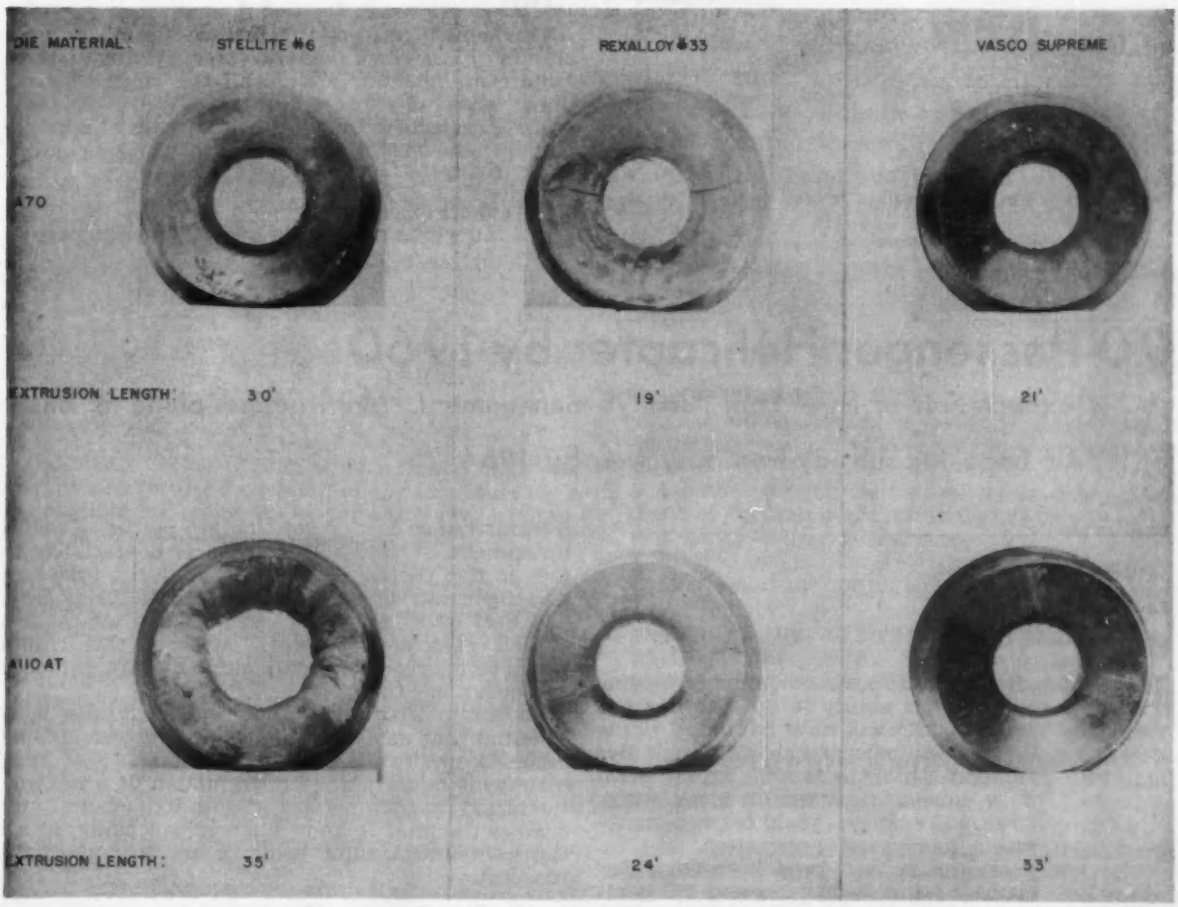


Fig. 4—Comparison of die condition after extruding A70 and A110AT through several die materials. Approximate die diameter is 3 in.

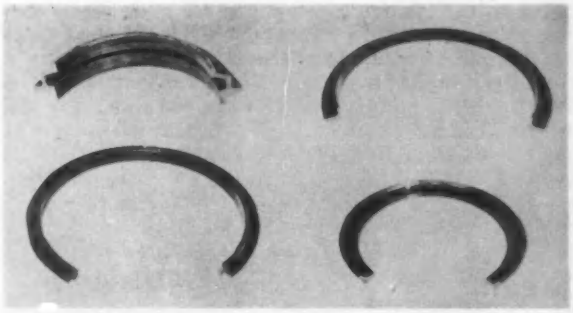


Fig. 5—Several typical formed and welded rings.

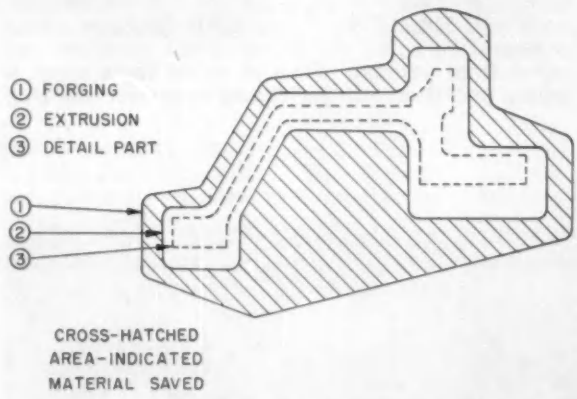


Fig. 6—Machining envelope comparison between forging and extruding.

concentricity. Fig. 5 shows several of the rings after forming and welding.

Economics

The high material utilization associated with the developed process coupled with the use of cast ingots as the extrusion stock resulted in an appreciable reduction of costs when compared to conventional forging techniques. For the variety of shapes examined cost savings were generally in the order of 25% and were, in some instances, as high as 40%. An additional advantage resulted in that the procurement cycle for the detail parts was reduced by 30%.

These results are summarized in the following table:

	Conventional Forging	Extrusion Forged Billet	Extrusion Cast Ingot
Material utilization, %	19	26	30
Part cost, $/lb	72	48	43
Cost savings, %	–	33	40
Procurement cycle, months	6	5	4

The above figures do not include savings on machining. The rings manufactured by this method require approximately one-half the stock removal of conventionally forged sections (Fig. 6). In general, this results in an additional savings of approximately one-fourth to one-third of the machining costs.

To Order Paper No. 14B . . .
. . . on which this article is based, turn to page 5.

20-Passenger Helicopter by 1960 . . .

. . . is expectation of New York Airways management. Multiturbine plane is basis of NYA's hope for subsidy-free operation by 1964.

Based on paper by

Glen B. Eastburn,

New York Airways, Inc.

THE 1960 helicopter will have two or more turbine engines and have the ability to fly with one engine out. This Ship "X" will have minimum vibration and noise and also be acceptable to people living in the neighborhood of the landing areas. With a payload of 20 passengers, 100-mph block speed, and 125-mile range, five ships should reach a break-even point within four years of operation.

The helicopter airline will be a high-frequency operation. Daily travel of 3000 miles and 250 landing would be possible with five Ship "Xs." This estimate gives a direct flight cost of $95 per hr and a maintenance cost of not over $95 per hr. Capital investment of $500,000 per ship is depreciated to 15% in five years. At the same time the price per passenger mile should drop from 42¢ to 30¢ by 1962.

A fleet of 10 Ship "Xs" would carry almost 2½ million passengers a year. Most of this traffic would be between terminals, similar to the present-day urban bus routes.

To attain satisfactory operational results it is essential that navigational aids and instruments be designed specifically for the helicopter. New York Airways is undertaking an evaluation of a navigational aid which operates at low frequencies, and enables the pilot to know his precise location at all times. Other similar projects are in immediate prospect.

To Order Paper No. 6B . . .
. . . on which this article is based, turn to page 5.

Daimler-Benz engineers see single-joint swing axle best as result of analysis of . . .

Passenger-Car Rear Axles

Excerpts from paper by

H. Scherenberg, R. Uhlenhaut, and J. Mueller

Daimler-Benz AG

IT IS BELIEVED that the Daimler-Benz single-joint swing axle with low pivot is the best type so-far developed for passenger cars as to vehicle behavior and with regard to manufacturing requirements, the authors say.

This concept results from analysis and comparison of DB swing-axle designs with rigid and de Dion types. This comparison led to some rather specific conclusions in regard to the possibilities and limitations of each type as regards riding behavior on straight and curved roads . . . also with regard to mass-production potentials.

Rigid Axle

ASSEMBLY CONDITIONS—Since space must be provided for the movement of the axle, there is a loss in trunk space. Lowering the center of gravity is only possible to a limited extent.

RIDING BEHAVIOR ON STRAIGHT ROAD—Effect on handling stability under the influence of disturbing forces (understeering tendency even at small curve μ—where curve μ is a nondimensional quantity that represents the ratio of the square of the driven curve speed to the product of the curve radius by the acceleration due to gravity).

The unsprung masses are comparatively large and can only be reduced with difficulty, so that the frequency range between the frequencies of the first and second degree of the coupled sprung mass vibration can only be increased to a limited extent.

This type gives a comparatively hard ride—as it is necessary to keep the inclination of the car as small as possible.

RIDING BEHAVIOR ON CURVED ROAD—Tendency for bad understeering in extreme curve (equal deflection constant with regard to the other axle types).

In understeering the car moves at first in the front of the curve and no longer responds in an emergency to the steering turn.

We find comparatively great but still tolerable inclination of the sprung mass.

MANUFACTURING VIEWPOINT IN LARGE-SCALE PRODUCTION—Simple manufacturing and assembling process, therefore very favorable in cost.

Normal Swing Axle

ASSEMBLY CONDITIONS—Necessary space for the swinging of the arms can be kept comparatively small. By securing the gear unit on the frame, the trunk space can be well utilized. Lowering the center of gravity is possible.

RIDING BEHAVIOR ON STRAIGHT ROAD—Effect on handling stability under the influence of dis-

turbing forces (understeering tendency with small curve μ).

The unsprung masses are small and can be substantially reduced; thus, there is a large frequency range between the resonances of the first and second degree of the couple sprung mass vibration.

The ride can be kept relatively soft, thus giving good isolation of the road shocks from the passengers.

RIDING BEHAVIOR ON CURVED ROAD—Tendency to oversteering with extreme curve μ.

With oversteering the car moves away at first in the rear. The front still responds to steering control. By countersteering the car can still be well controlled in any emergency.

There is only a small inclination of the sprung mass.

MANUFACTURING VIEWPOINT IN LARGE-SCALE PRODUCTION—Compared to the rigid axle this type is somewhat more complicated in manufacture and assembly and thus more expensive.

Racing-Car Single-Joint Swing Axle

ASSEMBLY CONDITIONS—When assembled in a passenger car, there is no great difference compared to the mass-produced passenger-car single-joint swing axle. Space conditions are similar to those with a normal swing axle.

RIDING BEHAVIOR ON STRAIGHT ROAD—Effect on handling stability under the influence of the disturbing forces (slight understeering tendency with small curve μ).

The unsprung rear-axle masses are very small, since the gear unit is mounted on the frame, unlike the passenger-car single-joint swing axle, and in the case of the racing car, reduction of the unsprung masses by arranging the brake drums inboard at the gear unit.

The ride can also be kept soft, as in the case of the normal swing axle.

RIDING BEHAVIOR ON CURVED ROAD—Tendency to slight oversteering with high curve μ. This type gives good adaptation to the desired curve behavior.

Inclination of sprung mass is somewhat greater than with normal swing axle, but less than with rigid axle.

MANUFACTURING VIEWPOINT IN LARGE-SCALE PRODUCTION—Comparatively complicated to manufacture: four universal joints are required in the entire driven shafts, two of which must slide in the axial direction with easy endwise movement under load. Assembly is difficult for large-scale production.

The axle is very expensive.

De Dion Axle

ASSEMBLY CONDITIONS—Similar to those with rigid axle, but less loss of trunk space, since the gear unit is fixed on the frame.

BEHAVIOR ON STRAIGHT ROAD—Handling stability is similar to the rigid axle.

The unsprung masses can be reduced, compared to the rigid axle, since the gear unit does not swing. As the selection of the instantaneous center can be selected freely within certain limits, depending on the lateral guidance, the ride can be kept soft, without increasing the inclination of the sprung masses.

BEHAVIOR ON CURVED ROAD—By selecting the axle kinematics it is possible to influence the oversteering and understeering. Conditions are more favorable than with the rigid axle but there is no major improvement as the camber does not change.

MANUFACTURING VIEWPOINT IN LARGE-SCALE PRODUCTION—The construction of the axle is more complicated than that of a rigid axle. Four universal joints, two of which must slide in an axial direction, are used. Manufacturing costs are similar to those for the racing-car single-joint swing axle.

DB Single-Joint Swing Axle for Passenger Cars

ASSEMBLY CONDITIONS—The space conditions are similar to those of a normal swing axle.

BEHAVIOR ON STRAIGHT ROAD—Effect in the direction of handling stability under the influence of disturbing forces (slight understeering tendency with small curve μ).

The unsprung masses are small. The masses of the left swing arm are about 0.1% larger than those of the right arm, since the rear-axle gear unit swings with a small lever arm from the pivot of the half axles.

The ride can be kept soft, as with the normal swing axle.

BEHAVIOR ON CURVED ROAD—With extreme curve speeds there is only a slight oversteering tendency.

The inclination of sprung mass is greater than with the normal swing axle, but still considerably less than with the rigid axle.

MANUFACTURING VIEWPOINT IN LARGE-SCALE PRODUCTION—Manufacturing and assembly conditions are similar to those with a normal swing axle.

Cost is somewhat higher than for the normal swing axle.

To Order Paper No. 108 . . .
. . . on which this article is based, turn to page 5.

Jet Transports need ground service to match their superior flight service

Based on paper by

Marvin Whitlock
American Airlines, Inc.

AMERICAN Airlines planners have concluded that the best way to handle the new jet transports at airports is to:

- Taxi the airplane straight in to the passenger gate.

- Load passengers from corridors level with cabin doors.

- Push the loaded and serviced transport out with a tractor to the taxi strip.

Ground Service Methods Need Changing

The advent of jets and turboprops calls for many changes in ground service methods. With relatively little more ingenuity and investment a substantial improvement in passenger environment can be attained to parallel the completely new standard of flight service.

These transports will seat 76–150 passengers. This will have the same effect on terminal size as simultaneous departures. It calls for more space at ticket counters, in lobbies and concourse. To meet this we are reviewing all areas and planning a departure room at each gate position to permit predeparture ticket collection.

More passengers mean more baggage to be handled in the same or less elapsed time than at present. Both the Electra and the Boeing will be equipped with baggage containers which will be preloaded and handled as a few units rather than loading each piece of luggage separately. Containers will be needed, also a hoist and special wheeled dollies for conveying the container to and from the baggage claim area.

Buffets will be larger, requiring more catering service. The larger floor area and greater number of seats mean more cabin cleaning. Entry for these services will be made through doors in the opposite side of the fuselage from the passenger entry. Larger ground units will be needed for potable water and lavatory service.

Since these are the first airplanes having volume sufficient to carry the weight the wing will lift, cargo will be carried and cargo conveying equipment of greater capacity and speed will certainly be needed.

What's Happening to Terminals

Turbine airplanes are having a profound influence on terminal areas and equipment. Some of the influences are:

1. Elimination of oil and air conditioning trucks.

2. Substantial increase in size of all remaining types of present equipment (exception is ground compressed air for engine starting when the system is not integral equipment).

3. Need for noise and exhaust blast protection equipment.

4. Introduction of strong incentives to improve ground servicing efficiency in terms of elapsed times and unit costs, and to improve passenger environment somewhat commensurate with progress in flight equipment.

These influences are reflected in the scale plan view on the next page of a Boeing surrounded by this equipment. This view also indicates the incentive to find room to move.

Minimum Requirements

The minimum requirement for conventional

taxi-in and taxi-out of the jet airplane are found to be :

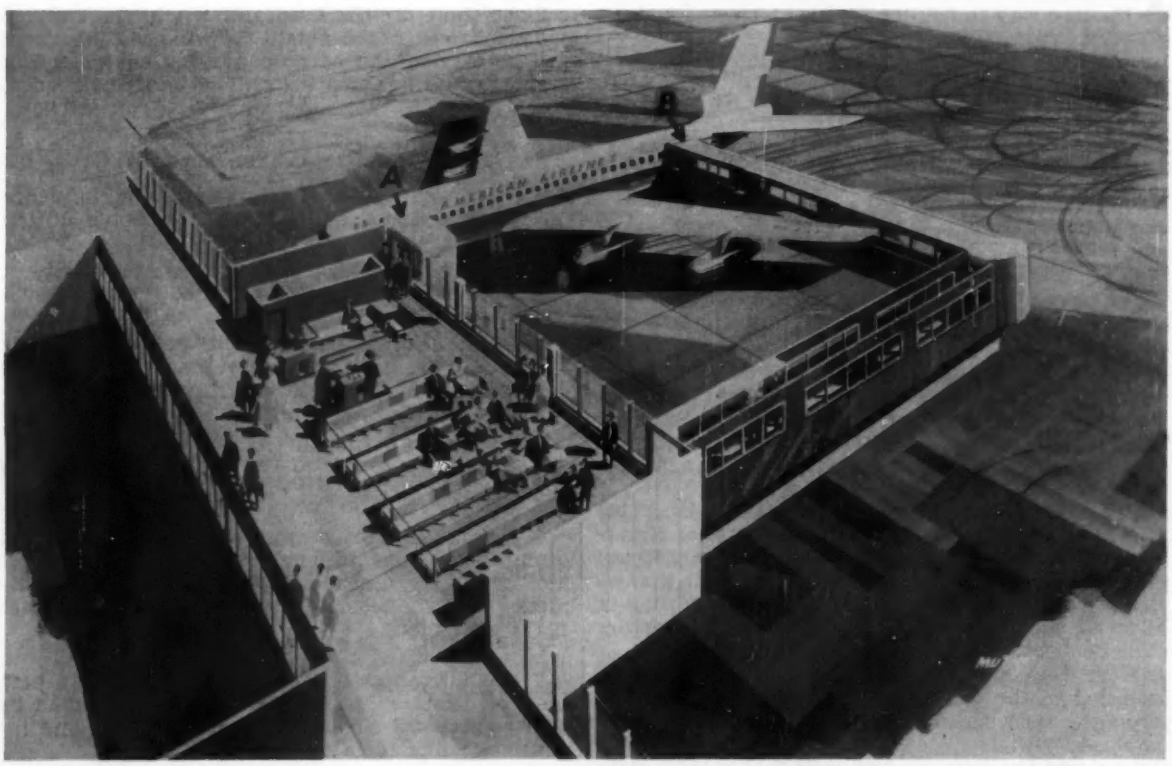
- All persons in the concourse area must be in a sound-tight enclosure having tightly sealed doors, which must be kept closed. These areas must be air conditioned and have remote air inlets.
- Ramp personnel on the apron during engine operation must be kept to a minimum and be protected with ear muffs or better.
- All other ramp personnel in the immediate area must be kept in sound-tight enclosures during engine operation.
- Gate positions must be separated by blast fences at least 7.5 ft high, approximately 110 ft long and abutting the concourse at the one end.
- Ground servicing units must have adequate capacity.
- Ramp cleanliness must be maintained better to avoid blowing dirt in dry weather, water in wet weather, and to make taxi lines visible under conditions of snow and ice.

But Even More Is Needed

These provisions will contain and protect at the gate being used and keep adjacent gates environmentally as they are now. The turbojet can be taxied to and from the gate using 200 ft in center gate spacing. Passengers can be loaded with conventional but powered stairs. However, there will be no improvement in the efficiency or comfort of terminal operation.

If these minimum facilities cannot be had, the compressor noise and exhaust blast must be excluded from the ramp area by one of the following methods:

1. Towing with conventional tractor or with powered wheel from/to a point at least 500 ft away from the terminal. This method is undesirable because of the time delay, particularly on arrival, the chance



TERMINAL FACILITIES for jet and turboprop transports. Here is pictured a Boeing 707 ready to take passengers aboard at front and rear doors (A and B). All passenger handling is at cabin floor level; all servicing, other than cabin service, is performed at ground level. Entry for cabin service is through doors in opposite side of fuselage from passenger entry. Gate positions are protected by blast fences.

of abusing the airplane structure, and the expense of towing equipment for long distance, all-weather towing.

2. Conveying passengers from the terminal to a remote loading position by means of buses. This method has promise for terminals larger than those now proposed for Idlewild and when calendar time permits development of the complete bus terminal runway layout.

Studying terminal arrangement led to making second level concourses and loading our first objective. This followed the realization that all the things to be done to an airplane are at ground level, with the exception of cabin service, for which special entry doors are provided. Moreover, the only level of interest to the passengers is the cabin floor level. Obviously, if the two interests can be kept separate physically, everybody gains.

It follows that if the airplane can be spotted accurately at the loading position, a better job can be done with built-in facilities such as fuel, water, and electricity, thereby eliminating mobile units.

Most for the Money

The foregoing reasons and further study led to the conclusion that a taxi straight-in, second-level loading, push-out with tractor and turn, unhook and taxi away, represented the most for the money. This plan represents the development of an arrangement described last year by H. O. Olson of Douglas[1].

Advantages

These are the advantages of the plan:

1. Straight-in approach directs compressor noise into the gate in use where it is contained, thereby protecting adjacent gates.

2. Exhaust gas is no problem.

3. All maneuvers are carried out at low engine powers with least noise, blast, and sweep of adjacent gates.

4. Smooth docking with no stops en route.

5. Front door deplaning starts within 30 sec of wheel stop.

6. Front door passengers receive distinctive treatment in a dual-class service operation.

7. Front door provides safe exit in case of ground fires such as from fuel spills.

8. Gate interchangeability is maintained with other 4-engine airplanes, furnishing weather, noise, and blast protection with no change in level.

9. Minimum of personnel exposed to noise; none exposed to blast.

10. Positive all-weather orientation allows precise positioning of airplane regardless of ground guidance.

11. Minimum gate spacing. Saving up to 30 ft per gate. (170 ft can be used if DC-6/7 pushed out same as 707.)

12. Minimum gate spring still allows wing span growth, and fuselage length growth is no problem.

13. Breakdown of handling equipment cannot deactivate gate.

14. Precise parking makes fixed servicing equipment practical.

15. Arrangement is adaptable to existing and planned concourses.

16. Tow-in procedure or flat-car handling can be used.

17. Any concourse configuration—linear, round, or multisided—can be used.

18. Both sides of airplane can be flooded with high-intensity lighting.

19. Provides minimum ground time. Passengers can deplane without waiting for coast down and can continue to board after engines are started.

20. Conventional DC-7 size tractors can be used.

Disadvantages

These are the disadvantages of the arrangement:

1. Passengers may feel push-out takes more time than taxi. Actually, method takes less time between boarding of last passenger and taxi-away.

2. Pilot's and tractor operator's vision is obstructed while airplane is being pushed to taxi position, requiring a monitored operation.

3. Some development costs and problems can be expected with rear door bridging device because of complexity of equipment and limited service experience.

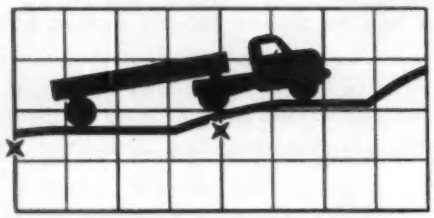
American Airlines will use this terminal arrangement for high-frequency stations and is now in process of incorporating the features in terminals now in the design stage.

Service Needs More Than Physical Assets

Facilities alone do not guarantee service. The history of the service industries affords convincing proof that leadership and respect are more often gained and held by outstanding human conduct, personality, and service than by the provision of better physical facilities. It is reasonable to assume, however, that any operator with both the facilities and these characteristics will have competitive advantage and win the blue ribbon of approval.

[1] "Planning for Handling Jet Transports at the Passenger Terminal," by H. O. Olson. Paper presented at SAE Annual Meeting, Jan 18, 1957.

To Order Paper No. 8A . . .
. . . on which this article is based, turn to page 5.



Predictions for Ability

Four vehicles check out the truck performance

Sum of Air and Rolling Resistance Hp
(Vehicle "A")

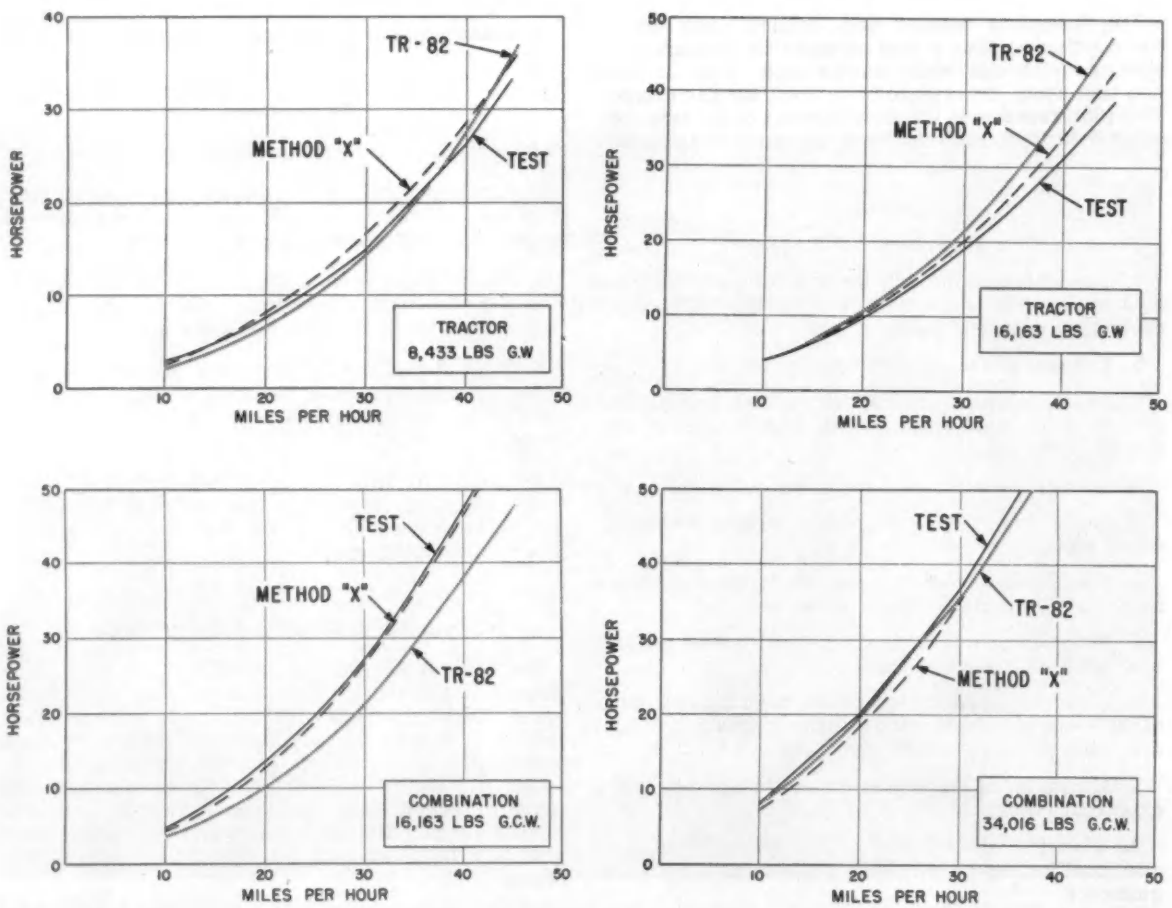


Fig. 1—Air and rolling resistances are measured for the extreme conditions of a 2¾-ton tractor with and without trailer. In each case the frontal area is the same. This throws the burden of accounting for change in performance on the rolling resistance hp in the TR 82 method of calculation. Method X was derived to match the test conditions of this vehicle.

Truck OK'ed

calculations recommended by SAE.

Based on paper by

A. F. Stamm,
Chrysler Corp.

PROOF of the SAE Recommended Practice on Truck Ability Prediction Procedure (TR 82) came from controlled tests on four vehicles. The actual test results are compared to the TR 82 method and a Method X developed specifically to match the performance of the first test vehicle, "A". In this way the accuracy of the recently revised TR 82 is checked to see if it compares favorably with equations set up for specific examples. Results showed that TR 82 and Method "X" calculations checked the performance of test vehicles "B," "C," and "D" equally well.

Fundamental Relationships Used

Horsepower is the basis of performance calculations in both TR 82 and Method X. The retarding factors on a vehicle, such as air resistance, rolling resistance, and chassis friction, are calculated as horsepowers at each speed. The difference between the sum of these powers and the net engine power is the reserve horsepower available for hill climbing or acceleration.

In TR 82 the following relationships are assumed:

Air resistance hp = f (frontal area and $\overline{\text{velocity}^3}$)

Rolling resistance hp = f (weight and $\overline{\text{velocity}^2}$)

Chassis friction hp = f (engine rpm and weight)

The basic method of approach for Method X is similar.

The constants needed in the above relationships come from test data. The most difficult part is separating overall results into the three retarding forces. Air and rolling resistances are usually lumped together in test measuring devices.

Test Results

Four separate tests were made on vehicle "A". Two were on bobtailed tractors, lightly and heavily loaded. The others were on a lightly and heavily loaded tractor-trailer with the same frontal area as the bobtailed tractor. Fig. 1 shows that TR 82 followed test results for the sum of air and rolling resistances closely for the normal configurations of a light loaded tractor and a heavy loaded combina-

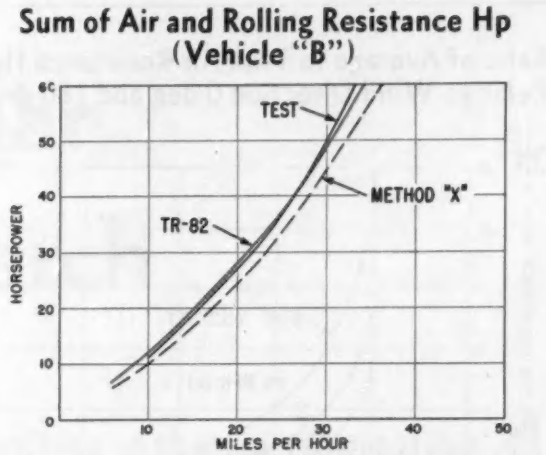


Fig. 2—A 2½-ton tractor-trailer combination loaded to 50,000 lb checked well with TR 82. Method X is based on the performance constants of vehicle "A" in calculation on the four test vehicles.

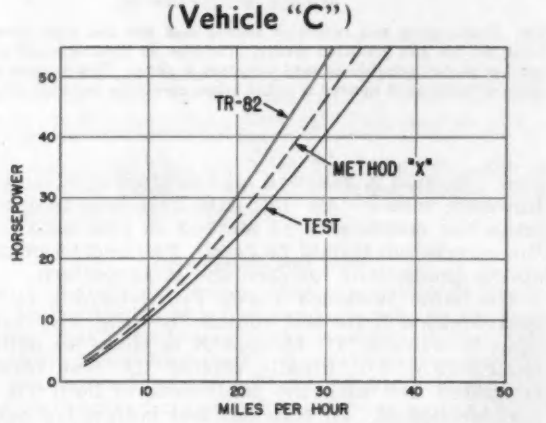


Fig. 3—The 3-ton tractor-trailer combination was tested with a 2-speed rear axle. Tests were made in seven gear selections. Although Method X is closer to test resistances, the calculated gradeability did not follow this pattern. TR 82 gave accurate predictions at high speeds and gear ratios while Method X was on the curve in first gear at speeds up to 7 mph.

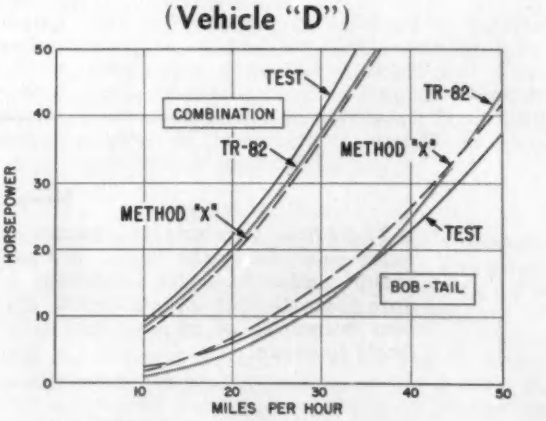


Fig. 4—Vehicle "D" was a 35,000-lb gcw tractor-trailer. It was tested in combination and with a 2½-ton tractor running bobtailed. Here both methods of calculation closely matched performance.

Ratio of Average to True Air Resistance Hp. Relative Wind Direction 0 deg and 180 deg.

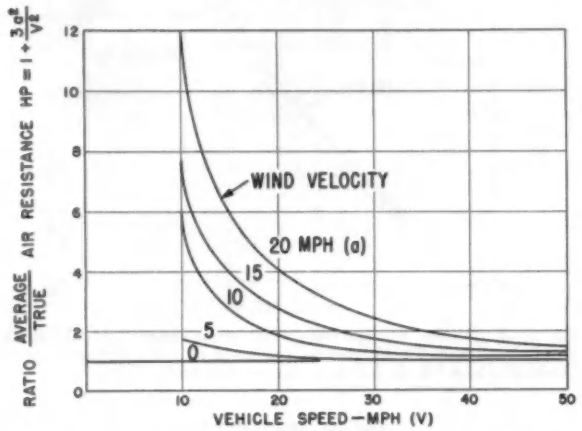


Fig. 5—Averaging test results of vehicle runs into and away from a wind will *not* give predicted results. The true air resistance will show too low in the calculations with too steep a slope. This happens because differences in squared or cubed values cannot be averaged out.

tion. Method X followed all configurations closely. However, vehicle "A's" test data were used to determine the coefficients of Method X equations and the correlation should be good. The overall gradeability predictions followed the same pattern.

The same yardstick shows TR 82 coming closer than Method X for test vehicle "B" (Fig. 2). However, in vehicle "C" Method X is closer to actual results (Fig. 3). Finally vehicle "D" test results compared well with the predictions of both TR 82 and Method X. In this last test both a bobtailed tractor and a combination vehicle configuration were run (Fig. 4). In this last graph, as well as some previous ones, the shape of the predicted TR 82 curve is steeper than the test results indicate it should be. This could be due to wind on the test track.

Wind Kills Accuracy

Performance predictions are all based on still air. It is felt that operators can rightly select vehicles on their still air ability. However, in running tests on a windy day the truck goes down the test track in both directions and an average of the two runs is taken to cancel the wind effect. This will **not** give correct results. Since air resistance hp depends on the $\overline{\text{velocity}}^3$, wind on the test track will always give higher resistance horsepowers. Fig. 5 gives the effect of averaging head- and tail-wind results. The ratio of vehicle speed to wind velocity must be high, 5/1 or better, before the error is negligible. In the tests run on the four vehicles the wind varied from 0 to 24 mph. This may account for the decrease in the actual slope of the air resistance and rolling resistance test curves of some vehicles.

The effect of a cross-wind is more complicated. Here the effective angle of the air striking the vehicle is not head on. The drag coefficients for the vehicle can change radically, depending on the streamlining of the truck. TR 82 does give a change in velocity correction for cross-winds, but this does not take the changing drag coefficient into account.

Performance Not Proved

In the tests, data were taken on chassis friction horsepower. The results were too limited and erratic to prove or disprove the calculations in TR 82. On vehicle "C" there was an indication that the chassis friction varied directly with rpm, as predicted. But the test points fell above the values obtained from TR 82.

The recent revision of TR 82 gives methods for calculating the times and distances required to accelerate through gears to a given speed. Since these calculations are based on reserve hp, their accuracy is only as good as the basic calculations. Actual test accelerations were not run.

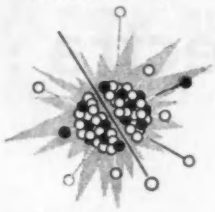
To Order Paper No. 21A . . .
. . . on which this article is based, turn to page 5.

Navy Lubricating Oils

■ *There have been no actual engine casualties attributable to the lubricating oils now being qualified by the Navy. But surveys show that fleet operations are now generally conducted under conditions of minimum engine stress. Large-engine test data indicate that, should highly stressed operation be necessary, high rates of engine casualties, or at least excessive maintenance to prevent casualties, are most likely to ensue.*

—H. F. King and L. G. Schneider

A feature of the



SAE Nuclear Energy Advisory Committee

Nuclear Research . . .

. . . is developing many opportunities in the transportation field. Power project research studies are under way.

Reported by

Ray McBrian

Member, SAE Nuclear Energy Advisory Committee

AN excellent example of the varied possibilities of nuclear research can be found in the application studies being undertaken in the transportation industry field. Power project research studies are definitely under way despite considerable feeling that the smaller nuclear powerplant will not be able to compete economically with the present conventional fossil-fueled energy powerplants, and adequate shielding will be a major safety undertaking.

Small Package Powerplant

Studies of a small package powerplant applicable to the transportation field have far greater implications than the competing with present conventional fuels in the United States. Such research projects, embracing the "desire to know" or curiosity as to why it cannot be done, may lead to many other important nuclear developments related to energy possibilities.

An example of such studies is that being made by Denver Rio Grande Western Railroad and the Baldwin-Lima-Hamilton Corp. for the development of a different type of powerplant for locomotive operation by having a nuclear free-piston package power unit suitable for locomotive application. Such studies are industry financed, and the Denver & Rio Grande Western Railroad has found that other nuclear possibilities are promising.

Irradiation of highly volatile coal results in coal particles being formed of less than one micron in size. These can be the colloidal part of a fuel oil and be burned in present diesel engines. With solid fuel particles of this micronic size, economical possibilities are present with such conventional fuels as diesel fuels. This railroad also has a program concerned with radiation studies of the conventional petroleum fuels of gasoline, diesel, and residual fuels for improving stability and combustion properties.

It is reported that the Army Transportation Corps has nuclear research studies directed toward land transportation possibilities.

Locomotives and Ships

It was found in Europe that a preliminary study of the possibility of a nuclear-powered rail locomotive has been made by the research staff of the German State Railroads. In Italy and especially in Switzerland, where rail electrification is already the transportation power means for railroads, studies toward using nuclear power stations supplying electrical energy to rail systems are to be made.

We have also found that British companies have completed preliminary research studies for nuclear propulsion of Civil cargo ships. Studies which have been made include a nuclear-powered turbine, both closed- and open-cycle types.

British companies expect to be building marine reactors for export. It is also reported that the Russians are developing a nuclear-powered rail locomotive through extensive research studies. None of these studies should be taken lightly, as something unexpected may be developed which will lead toward unexpected energy possibilities.

Radioactive Parts

In the land transportation and marine transportation field, irradiated piston rings, piston and other such technical irradiation studies are leading to a much greater understanding of the mechanism of wear and filtration.

The use of sulfur 35 as an integral part of diesel fuel has led to an understanding of the control of sulfur to prevent wear and corrosion by improving the combustibility of sulfur-bearing compounds. High-sulfur diesel fuels have been found to give wear performance results similar to low-sulfur fuels.

Cooling the Lockheed Electra :

Based on paper by

Bernard L. Messinger,

Lockheed Aircraft Corp.

A COMBINED air- and vapor-cycle refrigeration system will cool the passengers flying in the new Electra. The electrically powered 10-ton-capacity system will operate on the ground and in the air to provide airport-to-airport comfort without special ground cooling equipment. This overall performance is achieved at a weight of 35 lb per ton of cooling capacity.

Tracing the Cold Air

Fresh air headed for the passengers is processed in eight steps (Fig. 1). They are:

1. Fresh air is taken in at the two inboard nacelles and compressed by cabin compressors.
2. The hot compressed air then drives two turbines. These are used to pump in a separate supply of cooling air for the next step.
3. The fresh air is passed through two separate air-cycle heat exchangers.
4. It is then mixed with recirculating cabin air.
5. The mixed air is force circulated by a cabin fan.
6. In quick succession this air is passed through a Freon evaporation cooler,
7. A heater, and
8. A filter before it is pushed into the cabin.

The same process holds for flight station air conditioning. Fresh air is tapped off after step 3 and passed through a separate fan, evaporator, heater, and filter.

In both cases the heater is only used as needed. Also, the air cooling (step 3) can be bypassed.

Design Objectives

Four advantages result from the combined system. They are an outgrowth of the demand by air-

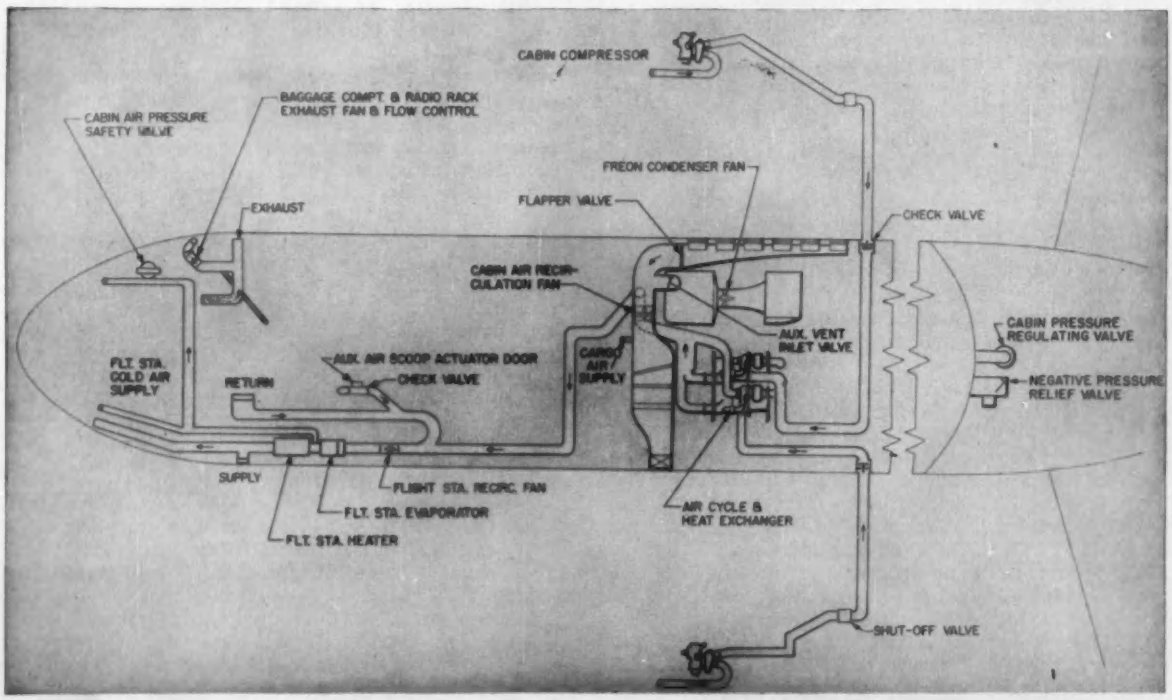


Fig. 1—Electra's air conditioning system bleeds fresh air into cabin and flight station recirculating air. Freon evaporators are mounted in pressurized areas near their heat load. This cuts down structural weight needed to run large air ducts through an unpressurized area.

A new apron-to-apron system cuts out ground cooling trucks.

line operators that special ground cooling trucks be eliminated, even at the cost of a slight decrease in airplane payload.

The first advantage is providing the power requirements of the airplane on the ground with a single electrical truck.

The second is the elimination of a fogging or icing problem which accompanies a high-capacity, bootstrap-type air-cycle system. In the Electra the air-cycle capacity is deliberately limited to removal of the heat of compression of the cabin compressors. The need for a fog separator is removed and the problem of its freezing avoided.

The third benefit is the insensitivity of a Freon system to altitude and cabin pressurization. The vapor cycle has an essentially constant efficiency and when not working at full capacity, its condenser cooling air drag can be reduced to a very nominal level.

Last is the increased reliability of a 3-section system. The two air cycles are deliberately separated until the mixing step. Thus either air cycle or the Freon cycle can fail without destroying all the air conditioning and causing delays.

Operating the Cooling System

Ground cooling is usually critical. Advantage is taken of the already cooled cabin air by bleeding only 10% fresh air into the system. This is possible since ground time is short and no smoking is allowed.

In flight the bleed air is stepped up to 70%. Now the cabin compressors supply hot, near-sea-level-density air. At the same time the hot compressed fresh air drives the turbines which provide cooling for the air-cycle heat exchanger. The cooling problem tapers off at altitude as lower temperatures are met. Then the high-efficiency Freon system can be cut back, reducing the drag caused by the air needed for its condenser (Fig. 2).

Choosing the Components

Conventional cabin compressors are directly driven through a fixed gear ratio by the constant-speed Allison 501 powerplant. Stability and control of the compressor airflow is achieved by a combination of variable-pitch inlet guide vanes, a surge-anticipating bypass control, and a surge-sensitive spill valve.

A double turbine and single heat exchanger form the heart of the air cycle. The turbines supply the

Performance of Lockheed Electra Refrigeration System

(Ground operation—engines not running; Freon-114 vapor cycle)

Design Conditions

Ambient temperature, F	100
Stabilized cabin and flight station temperature, F	80
Percentage of outside air, %	10
Cabin evaporator airflow, lb/min	151
Cabin evaporator inlet air temperature (10% ambient), F	88
Cabin evaporator inlet specific humidity, gr/lb dry air	50
Flight station evaporator airflow, 16/min	30
Flight station evaporator inlet air temperature, F	84
Flight station evaporator inlet specific humidity, gr/lb dry air	42
Condenser cooling airflow, lb/min	350

Estimated Performance

Evaporators

	Cabin	Flight Station
Airflow, lb/min	151	30
Air outlet temperature, F	49	42
Specific humidity of outlet air, gr/lb dry air	39	35
Air side pressure loss, in. H_2O (wet core)	1.5	1.5
Freon flow, lb/min	50.6	10.05
Freon evaporator temperature, F	35	35
Amount of Freon superheat at outlet, F	5	5
Sensible heat load, Btu/hr	85,500	18,100
Latent heat load, Btu/hr	14,600	1,800
Total heat load, Btu/hr	100,100	19,900

Condenser

Air side pressure loss, in. H_2O	4
Freon flow, lb/min	63.75
Freon inlet temperature, F	165
Freon outlet temperature, F	150

Compressor

Freon flow, lb/min	65.15
Adiabatic efficiency, %	71
Shaft power, hp	25.5
Freon flow for motor cooling, lb/min	4.5
Motor efficiency, %	87
Required electrical input power, hp	27.9 (20.8 kw)
Motor power factor, %	91.5
Motor electrical input, kva	23.9

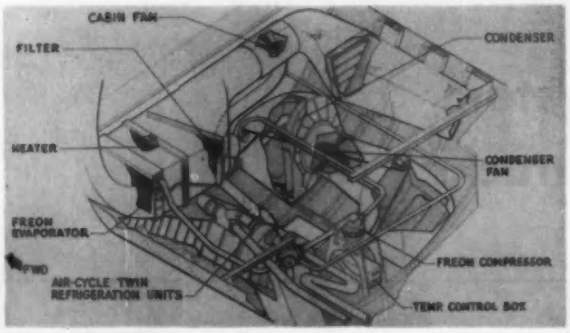


Fig. 2—Separate cooling air is supplied to the Freon condenser (top) and air heat exchangers (bottom). The first uses a scoop door and an electrical fan while the second has a flush constant-area inlet and a turbine-driven fan.

power to draw cool air through the heat exchanger. This assembly is centrally located together with the major portion of the air conditioning equipment in an underfloor compartment forward of the wing.

An electric drive for the vapor cycle won out over pneumatics because of the high fuel consumption penalty incurred by bleeding the compressor of a turbine engine, and the single type of ground power required, namely 400-cycle, 208-v, a-c current. Other advantages are: hermetically sealed motor compressor unit, no rotating shaft seals, quiet operation, and simple lubrication. Disadvantages are a slight increase in weight, fixed operating speed (23,000+ rpm), and need for constant-frequency a-c power.

A 2-stage centrifugal Freon compressor was chosen for its minimum of wearing parts, low noise and vibration, light weight, mechanical simplicity, and good efficiency. The closest competitor is the rotary-type compressor. Flow instability is overcome by use of vaneless diffusers and a discharge-flow-controlled bypass between the lower zone of the condenser and the inlet of the compressor. This allows external throttling for temperature control while Freon flows through the bypass (Fig. 3).

A compromise produced Freon-114 as the refrigerant. F-11, F-21, and F-113 all had outstanding thermodynamic efficiency but were eliminated because of chemical instability, corrosion, operating and shutdown pressures, and unavailability. The other two tested, F-12 and F-22, are applicable to positive displacement compressors.

Installation

The vapor-cycle components are split up to cool the cabin and flight station at minimum weight. The reasons are:

- A completely unitized system would put all components together in an unpressurized accessible area. However, large ducts are then necessary to bring the cabin and flight station air to the system. Also, a large unpressurized area near the cabin would add structural weight penalties.

- Separate systems for the cabin and flight station would require duplication of all structural and functional provisions and also double the maintenance problem.

To Order Paper No. 224 . . .
. . . on which this article is based, turn to page 5.

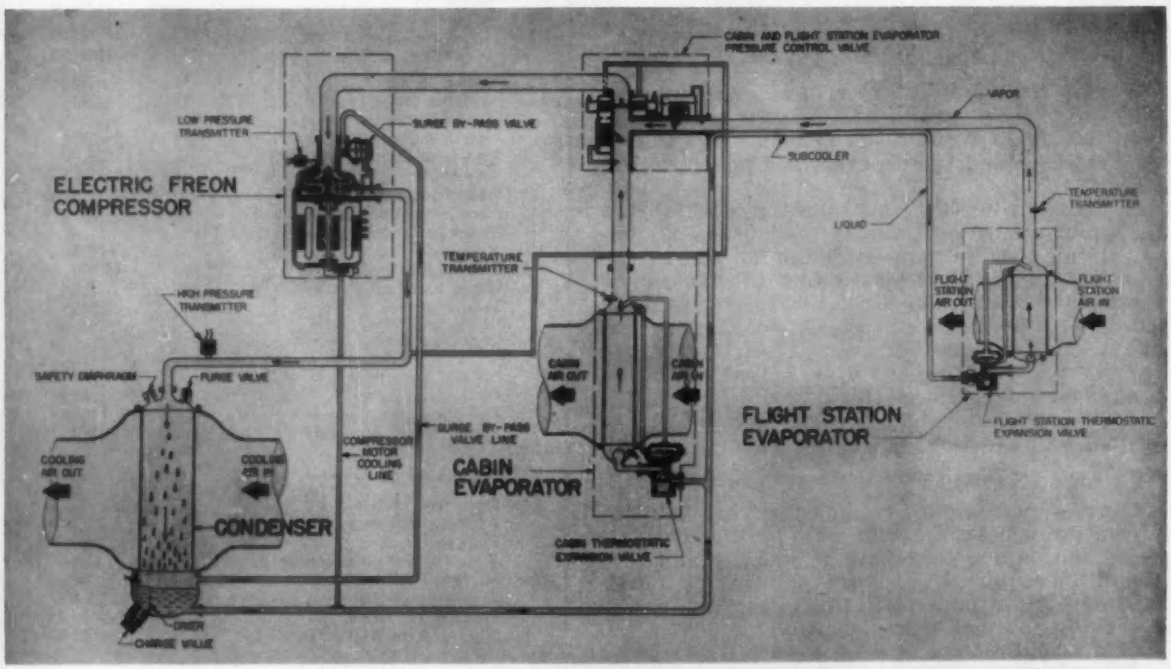


Fig. 3—Freon system supplies independent cooling for the cabin and flight station. The electric motor of the compressor is cooled by a small flow of Freon from the condenser. Lubrication of the bearings is accomplished by less than 1% of oil in the Freon.

Wanted: Product Design Engineers . . .

. . . qualified by education, practical training, and initiative to turn ideas into useful, manufacturable, saleable products.

Based on paper by

C. J. Scranton

Allis-Chalmers Mfg. Co.

RECENT graduates cannot be expected to meet all qualifications in full. Practical training will be needed to develop men to full competency. And while the novice engineer has certain responsibilities to the job and the company for which he works so, too, has the company responsibilities for the budding engineer. This two-way responsibility is important, and is worth elaboration.

What Industry Expects of the Graduate Engineer

- Appreciation of the continuing nature of the educational process. Adding practical experience to theoretical knowledge takes time.
- A trained mind, ability to think logically, to analyze and classify data, and to express oneself with clarity.
- Willingness to gain practical experience in design, drafting room procedure, manufacture, shop practice, or field operations. Also willingness to work on ideas originated by others.
- A continuation of study after graduation to keep abreast of new methods, new processes, and advanced thinking in his industry.
- Respect for the purposes of the drawing board—use, not the avoidance of it. Much thoughtful effort is required to translate ideas into coordinated mechanisms via this medium.
- Appreciation of the value of time spent in the factory, laboratory, on cost analysis, planning with field operation, and other phases of training.

What the Graduate Engineer May Expect from Industry

- A thorough understanding of the nature of the company, the type of products it manufactures, and the objectives of the industry.
- A training program which adds to his education and helps to make him a finished product designer.
- Encouragement to submit ideas for product improvement, with the graduate willing to have them stand the acid test of criticism.
- An opportunity to follow his design work during field testing in order to get first hand knowledge of shortcomings.
- As his experience progresses, make projects available to encourage idea participation.
- Compensation commensurate with his training, and the knowledge that rewards will be measured by deeds, not by the number of graduate degrees.

The graduate engineer must have a technical education which includes a fundamental knowledge of mathematics and the ability to apply this education to the analysis of stresses and strains and the determination of the strength of materials. But there are other things which should be listed as:

Characteristics of a Good Product Engineer

- Possess a knowledge of:

1. Availability of materials and how to use them wisely from a strength and cost standpoint.
2. Various methods of transmitting power through gears, belts, joints, bearings, and other applications.
3. Pattern making and good foundry practice. Some knowledge very helpful and essential in some industries.
4. Fundamentals of machine shop practice, welding, stamping, sheet metal work, forging, heat treating, and the like.
5. Production costs.
6. Patent law and its purpose, to some degree.

- Be unafraid of failure. All good design comes the hard way.
- Be willing to help with ideas from whatever source.
- Give careful attention to detail.
- Accept criticism as part of the job.
- Possess a sense of humor and remember that nothing is quite as good as it seems, nothing quite so bad as it appears.
- Have the ability to evaluate objectives.
- Realize there is no substitute for hard work; no short cut to good design.

The Future of Product Engineering

The product engineer of 1957 has at his disposal a wide choice of materials and processes unknown to the designer a few years ago. Coupled with this there is available precision manufacturing equipment for the building of most anything the human mind can conceive. Surely the wise choice of these facilities will be reflected in improved designs and product performance.

To Order Paper No. 187 . . .
. . . on which this article is based, turn to page 5.



Air Suspension

The principles and potentials of air suspension for motor vehicles have been actively worked on by automotive engineers for many years. SAE Journal had its first article on this subject in 1936.

Then last year, Cadillac made the first application to passenger car practice. (SAE Journal, June, 1957, pages 42-46.)

And now, as indicated in the Air Suspension section of SAE Journal's December issue "Trends in 1958 Car Design," almost every manufacturer has air suspension of one type or another.

In this article, SAE Journal focuses the latest information on various specific applications, which has been brought to SAE within recent weeks.

The information presented in this article is based on the following papers:

"The Ford Approach to Air Suspension" (Paper No. 9C)
by **C. F. O'Shea,** Ford Div., Ford Motor Co.

"The Oldsmobile New-Matic Ride" (Paper No. 9E)
by **R. W. Perkins,** Oldsmobile Div., General Motors Corp.

"The Air Spring—A New Factor in Rambler Suspension" (Paper No. 9B)
by **W. S. Berry,** American Motors Corp.

"The 1958 Pontiac Air Suspension" (Paper No. S36)
by **H. Aldikacti,** Pontiac Motor Div., GMC

"Compressed Air Spring or (Head Shrinkers Outdone)" (Paper No. S31)
by **C. O. Slemmons,** The General Tire & Rubber Co.

"The Chevrolet Level Air Suspension" (Paper No. 9D)
by **K. H. Hansen, R. E. Denzer;** and **J. F. Bertsch** Chevrolet Motor Div., GMC

"The Air Poise Suspension—Buick's Solution to the Air Ride Problem" (Paper No. 9A)
by **F. McFarland, E. G. Peckham,** and **Eric Dietrich,** Buick Motor Div., GMC

To Order any of the above papers . . .
. . . on which this article is based, turn to page 5.

Ford's Approach to Air Suspension

Based on paper by

C. F. O'Shea,
Ford Motor Co

FORD'S air-suspension system is of the so-called "open" type, that is, one which exhausts spent air from the springs into the atmosphere. It features 2-speed automatic height and leveling control—fast leveling when the doors are opened and load changes occur, slow leveling when the car is in motion with doors closed.

Air for the system is supplied by a single-cylinder, aircooled pump of 2.71 cu in. displacement. The pump is belt-driven by the engine at about engine speed and is lubricated by engine oil. Balance pressure is approximately 300 psi and maximum power requirement about 1 hp.

The 400 cu in. air reservoir is mounted in the right front fender and connected to the compressor by flexible hose. A one-way check valve prevents airflow from reservoir to compressor when the engine is not running. At the low point of the reservoir there is a drain valve for the removal of any moisture accumulation.

A diaphragm-type regulator or reducer valve maintains a lower system pressure than that of the reservoir (300 to 150–160 psi) so that air supply is adequate for the system when the compressor is not running. It also maintains the required balance be-

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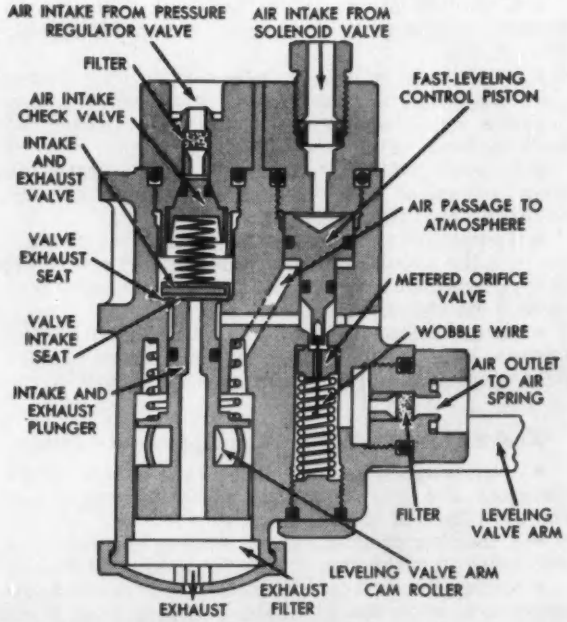


Fig. 1—Cross-section of Ford leveling valve. Left portion of valve controls normal leveling; right portion controls fast leveling, actuated by dome light switches on door hinge pillars.

Oldsmobile New-Matic Ride

Based on paper by

R. W. Perkins

Oldsmobile Division, General Motors Corp.

BASIC components of the Oldsmobile air-suspension system comprise a new frame which differs from that used on steel-spring-equipped cars, 4-link rear suspension, diaphragm-type air springs, air compressor, high- and low-pressure tanks, and controls for automatic constant height.

A rubber-insulated, 4-link suspension (Fig. 1) is used at the rear to hold the rear axle in position. The rear air springs are mounted on the axle housing independently of the suspension links and used solely to control ride. The upper suspension links are mounted diagonally to provide lateral control of the axle and, together with the lower links, absorb drive and braking torque and control fore-and-aft motions. The lower links are adjustable to permit optimum setting of the differential pinion angle. The 4-link suspension provides a high rear roll center and is designed to minimize rear "squat" and brake lift.

The diaphragm-type air springs are designed to

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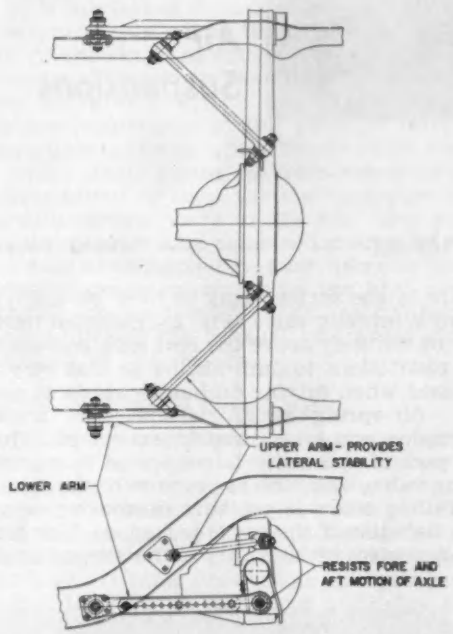


Fig. 1—Rear 4-link suspension holds axle in position, provides high rear roll center, and is designed to minimize rear "squat" and brake lift. Upper links are mounted diagonally to provide lateral control of axle. Coupled with lower links they absorb drive and braking torque and control fore-and-aft motion.

Rambler Puts Air Springs on Rear Only

Based on paper by

Wallace S. Berry

American Motors Corp.

THE air suspension offered by Rambler employs a Goodyear rolling lobe air spring, designed to go inside a coil spring. The combination coil and air springs are utilized on the rear wheels only (Fig. 1). This arrangement enhances the 4-coil spring suspension by using the air springs for leveling and for maintaining essentially the same ride characteristics whether the car is empty or loaded.

Most of the weight of the empty car is carried by the steel springs, which have the relatively low rate of 60 lb per in. for the sedan and 96 lb per in. for the station wagon. These rates are approximately 30% lower than those used on identical cars without air suspension. The rear coil spring rates are lower because the air spring contributes the additional rate needed for good ride and stability.

There is 20 psi pressure in the air spring when the car is empty and each spring supports about 100 lb. The steel spring supports 500 lb. As load is added, a leveling valve senses the change and increases air pressure so that the air springs carry the added load. In a loaded station wagon the air

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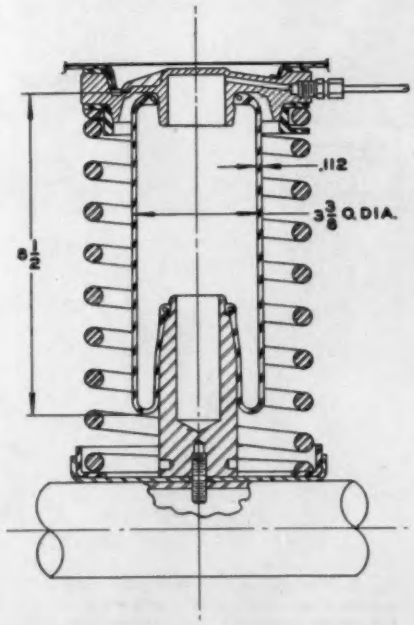


Fig. 1—Goodyear rolling lobe air spring fits inside coil spring to provide Rambler with rear air suspension. Most of car weight is carried by steel coils, but as load is increased it is carried by air springs.



Air Suspensions

Rambler — — — — — — — Continued from page 51

pressure in the springs may be over 100 psi.

A single leveling valve (Fig. 2), mounted near the center of the body above the rear axle, contains ball check restrictions to limit airflow so that very little air is used when driving on bumpy roads at normal speed. Air-spring design permits 4-in. travel in compression and 4-in. travel in extension. The exhaust port of this valve is connected to a pressure limiting valve, which keeps pressure in the air spring from falling below 18 psi, thus preventing complete spring deflation if the car is jacked up. The car can be transported without air in the system and can be driven in emergencies without air supply. Ample air for normal operation can be had by running the engine for approximately half a minute.

The air spring is built up in layers like a tire. An inner layer of neoprene is covered with two layers of nylon cord fabric which, in turn, is protected by an outside cover of neoprene. The cord angle is controlled to give the spring the necessary 520-psi burst strength and physical characteristics.

Air Supply Components

A Bendix-Westinghouse compressor with 2.7 cu in. piston displacement supplies 1 cu ft of air per min at 150 psi at 50 mph. It is driven from the engine by belt and runs 1.1 times engine speed on the V-8 engine, 0.85 times engine speed on the 6-cyl engine. The engine oil system provides lubrication. Maximum air pressure is approximately 300 psi. Fig. 3 shows the layout of the air system.

A 280 cu in. supply tank is located under the right front fender. From it air is piped to the air springs through 3/16-in. heavy wall nylon tubing connected with self-aligning fittings. The total volume of both air springs is 110 cu in., a volume which supplies more than ample air for leveling.

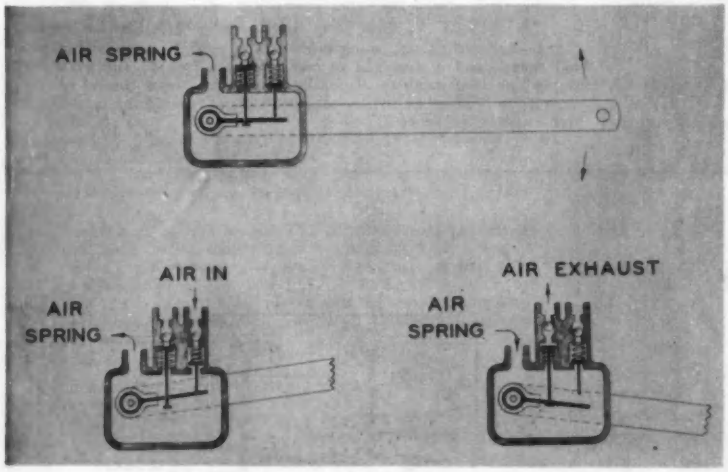


Fig. 2—Schematic of Rambler leveling valve showing air intake and exhaust action. Exhaust port of valve connects with pressure limiting valve, which keeps pressure from falling below 18 psi.

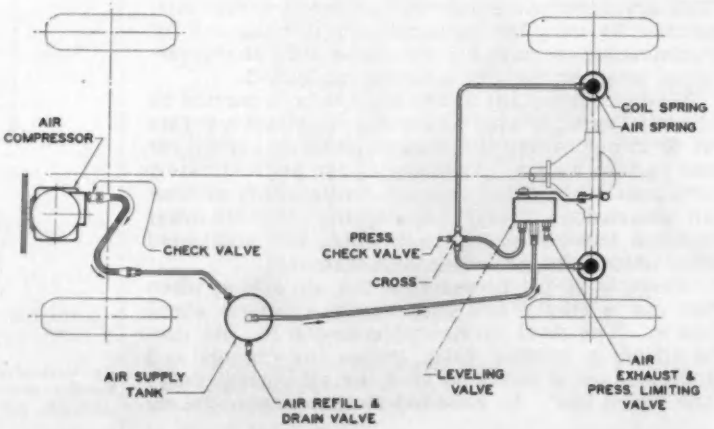


Fig. 3—Rambler rear air suspension gives maximum interchangeability with standard coil spring suspension, and stresses simplicity for manufacture and servicing. It has only 16 air connections.

Pontiac Using Modified Closed-Cycle System

Based on paper by

Hulki Aldikacti

Pontiac Motor Division, General Motors Corp.

(presented before SAE Detroit Section)

IN the Pontiac air-suspension system, which comprises basically an air compressor, air tank, height control valves, and air springs, the exhaust air from the springs is released to the atmosphere and/or to the intake of the compressor. Thus, it is characterized as a modified closed-cycle system (Fig. 1).

The front two springs are interconnected by an orifice and one valve admits and exhausts for these two springs at the same time. Each rear spring is controlled by an individual wheel valve.

The compressed air tank is connected to a pressure regulator valve with outlet leading to the front height control valve and both rear height control valves. These valves are connected to the springs and their exhaust line runs back to the pressure regulating valve again. In turn, the pressure regulating valve leads to a junction block which exhausts air to the atmosphere and/or the compressor intake. The junction block is located in the carburetor air cleaner, which doubles as a silencer and air cleaner for the system.

Compressor Details

The compressor is a single-stage, twin-cylinder, 90-deg V-type assembly, having a displacement of 5 cu in. per revolution and terminal perssure of 250 psi. It is lubricated from a reservoir mounted on the rear, and is driven by the power-steering pump pulley (if the car is so equipped) and mounted on the engine. The compressor uses the engine air cleaner for intake air.

The pressure regulator and override valve combination unit is placed on the frame under the firewall. It is a simple spring-loaded device which regulates pressure of air from the high-pressure tank to the height control valve to 125 psi. This valve is manually controlled by cable connection to a knob on the dash so that the driver can override the control system simply by switching the high-pressure side to the exhaust line. The regulator valve has a 0.030-in. orifice at the exhaust side which restricts the exhaust of the springs.

Height Control Valve

All height control valves are mounted solidly to the frame. The valve at the front is connected to the roll bar, while those at the rear are connected to the rear-suspension lower control arms (Fig. 2).

Each valve body contains two Schraeder valves which are operated by an arm. The valve body is normally at the same pressure as the spring and is connected to it with a ball check restricted fitting. The intake valve from the reservoir is a push-type valve and also a check valve in series, which prevents leakage of air from the spring to the high-pressure tank in the event that tank pressure drops below spring pressure. The exhaust valve is a pull-type valve, normally sealed by the pressure in the tank body. The arm is provided with an adjustable dead band between intake and exhaust which regulates the sensitivity of the valve.

Air spring cars are designed for lower wheel rates, and for such rates considerably less friction can be

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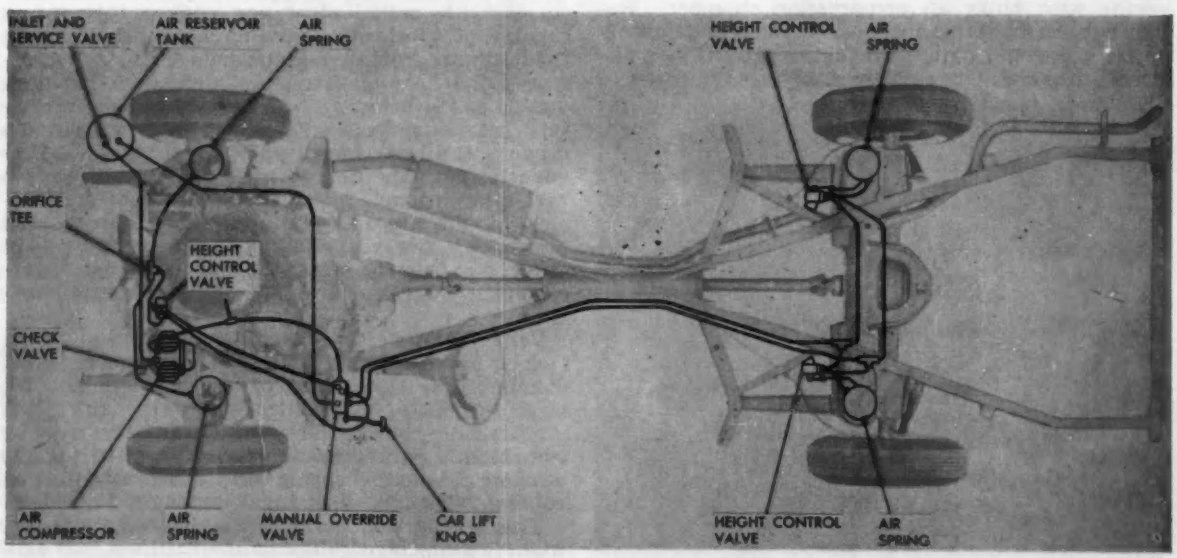


Fig. 1—Layout of Pontiac's modified closed-cycle air-suspension system.



Air Suspensions

Pontiac

—Continued from page 53

tolerated in the suspension since the decrement per cycle for coulomb damping is inversely proportional to the spring rate of the system. The magnitude of friction in the standard Pontiac car suspension is satisfactory for coil springs; however, for the lower rate of air-spring suspension, rubber bushings on the control arms are specified. These bushings add some rate to the system but it has been compensated for by the design rate of the air spring.

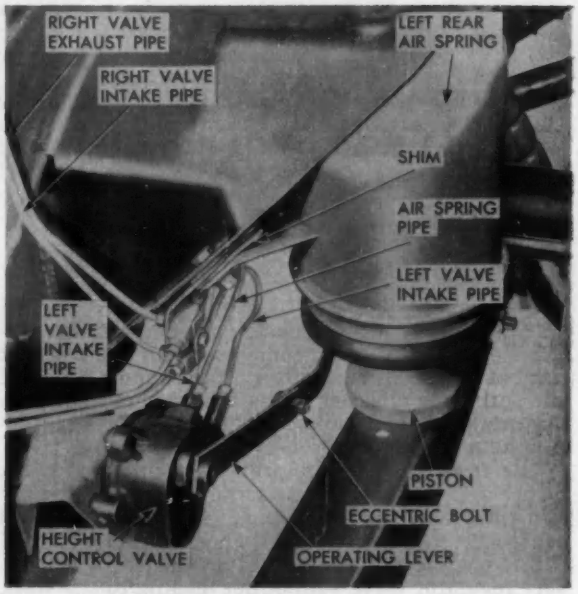


Fig. 2—All four Pontiac springs are basically alike except for front and rear piston contour and volumes, which vary for different arm ratios and different wheel rates and loads. Here is shown the left rear spring with its height control valve.

General Tire Launches New Air Spring

Based on paper by

C. O. Slemmons
General Tire & Rubber Co.
(presented before SAE Metropolitan Section)

GENERAL Tire's first air spring was designed for trucks and buses and featured a long, narrow spring with bulky air compression chamber. Because it was too large for most trucks and definitely so for passenger cars, a shrinking process was undertaken which led, step by step, to a reduction in size and weight and elimination of the bulky compression chamber. The end point is the present spring, which represents the smallest package possible for a given pressure (Fig. 1).

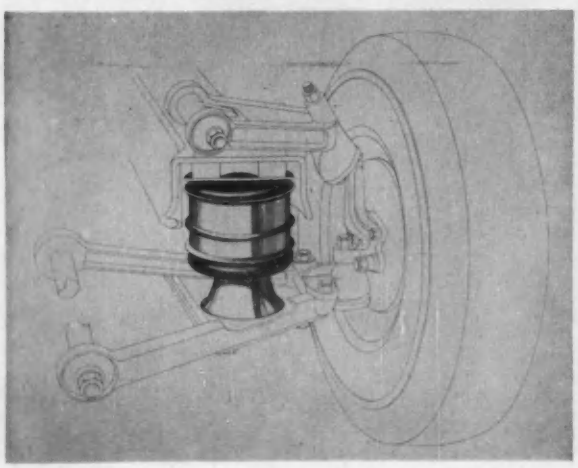


Fig. 1—Front wheel mounting of General Tire's air spring.

The first success with the shrinking process came with a spring which has a fairly constant area versus height curve. It approaches a frictionless piston and cylinder arrangement, termed a rolling diaphragm, but it has important differences. The conventional rolling diaphragm has one piston whereas this has two, one at each end. The use of two pistons with a floating center, together with considerable radial clearance, makes this spring capable of substantial misalignment not found in the ordinary rolling diaphragm. This spring removed the floor on frequency which we had been unable to get below with long, narrow, or circular-type bellows springs. They held us above 80 cpm because the area increased with deflection. Frequencies with the new spring can be below 40 cpm with a large compression chamber. While frequencies this low are unlikely to be used on trucks and buses for a few years to come, it is very much in order to go below 80 cpm. Frequencies in passenger-car springs are in the 40–60-cpm range and going lower.

Vehicle designers still complained of cost and the lack of space for the compression chamber. Total volume three times that of the spring made too large a package. The central-band-type spring had a practically constant area and it did seem as if we were fighting the irrefutable gas laws in trying to develop a low-rate spring with small compression volume. Then came a break-through.

This spring was found to have a very low rate when it misbehaved. The band would not stay centered and as it rolled off center the effective area of

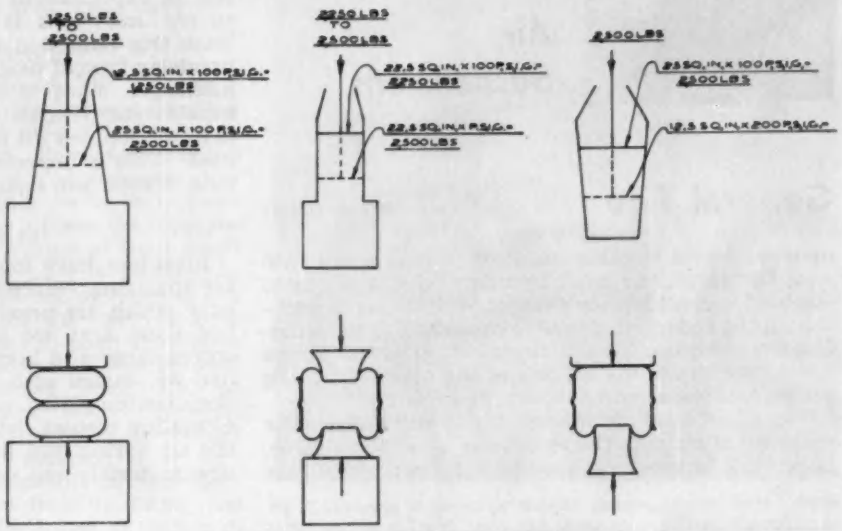


Fig. 2—Three stages in development of General Tire air spring, which resulted in reduction in size and elimination of bulky air compression chamber.

the spring would drop during compression. We had been correcting this defect by designing the pistons with a slight taper, the large end being outward. This held the band central and the spring resumed good behavior. When it was appreciated that this malfunctioning answered the problem of reducing the air spring package, we were set to develop springs which would fit in small places and produce very low rates.

The Small Package Emerges

If the effective data (load divided by pressure at a given spring height) is made to decrease and so overcome the pressure rise due to compression, a low-rate spring can be had with a small compression volume. This is what happens with this new spring except that the area is reduced only fast enough to get the desired rate.

The problem was now to find the proper relationship of the components and the shape they would take. To make the band hold still, one piston was removed and the other was made approximately twice as long. Fig. 2 shows the 3-stage development of this spring.

The slope of the piston combined with available air volume determines the frequency near design height. A low frequency also can be developed with a straight piston by increasing the size of the loop, but there are at least three disadvantages:

1. The OD of the spring becomes larger for a given capacity.
2. The low-frequency portion of the stroke is rather short.
3. The stress on the cord goes up.

The small loop is made possible by the floating band. It lets the air cell follow the piston, keeping the loops fairly equal and controllable. Where the spring is placed on a lever arm at a short distance from the pivot, there is a severe angle change which makes this feature of the design very desirable. On most suspensions there is angular displacement between the spring axle pad and the frame. The spring will accommodate this misalignment with little effect on its performance or life.

Application to Truck and Trailer Tandem

When this spring is adapted to truck and trailer tandems, the large rate change with relatively small volume change makes it possible to have very low individual wheel rates with a considerably higher collective rate. In sway, or when the vehicle is taking a large undulation, the rate is high enough to give control and to prevent bottoming. The in-

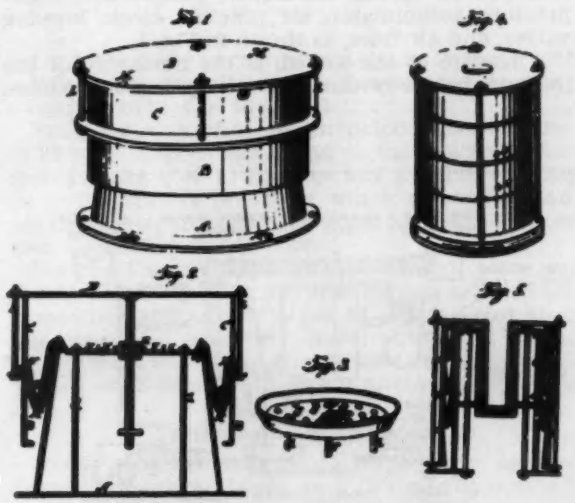


Fig. 3—Old patents on air springs show real thinking on the part of the early inventors. They aimed at a small package.



Air Suspensions

General Tire

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dividual wheel striking an obstacle has a low rate and, therefore, the most common type of shock to the load is considerably reduced, and this is in addition to the reduction due to equalization of the axles. It occurs because the individual wheel action allows the spring to use the volume of the opposing spring as an additional compression chamber.

The small total air volume drastically reduces the quantity of air required to raise or lower the vehicle. Less work is required because a higher percentage of the work done goes toward lifting the vehicle and less is expended in compressing the air and, of course, less work is required of the compressor. With this reduction in demand for air the simple, nondelay type of height control valve becomes more attractive, since it can be throttled down, using considerably less air dynamically when the vehicle is in motion, yet fill fast enough when picking up a load. This is important when several axles on one long vehicle are equipped with air springs.

It's So Old It's New

Inventors have long considered ways to use air for springing vehicles. Looking backward at patents, which are presented in Fig. 3 in the order of last issue first, we see that we need never have gotten large and been forced to practice shrinking had we started with one of the earliest configurations contemplated. Early inventors had no means of sealing pistons, let alone a frictionless one, and the air spring had to wait on its development for new materials and new fabrication methods.

Chevrolet Suspension Features Interchangeability

Based on paper by

Kai H. Hansen, R. E. Denzer and J. F. Bertsch

Chevrolet Motor Division, General Motors Corp.

CHEVROLET has made its new air-suspension system easily interchangeable in production line assembly with standard full-coil suspension by adopting a 4-link-type rear suspension with short and long arms.

Basic components of the new air-suspension system are air-spring assemblies, compressor, high-pressure accumulator, air junction block, leveling valves, and air lines, as shown in Fig. 1.

A feature of the system is the mounting of the leveling valves within the air-spring assemblies.

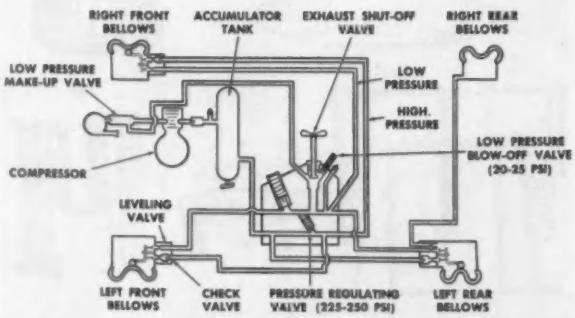


Fig. 1—Schematic of Chevrolet air-suspension system.

These correct riding height continuously at a moderate rate regardless of whether the springs are leveling a load or operating in ride motion. Two leveling valves are used in front, one in each spring, and a single valve is installed in the left rear spring. The left rear spring is cross-connected to the right rear spring, which is without leveling valve. To keep crossflow between the two from interfering with the handling of the vehicle, a 0.20-in. orifice is installed in the balance line.

How the Control System Works

An engine-driven compressor maintains circulation of air in the system and takes in make-up air as required. A complete circuit of lines is provided for the flow of air from the high-pressure reservoir through the air springs to the low-pressure or suction side of the compressor, forming a closed system for any given load. To limit pressure in the reservoir to 250 psi, a relief valve bypasses the air back to the low-pressure side of the circuit.

The flow rate of the air is controlled by orifices in the wheel valves. Inlet and exhaust orifices in the front valve are 0.20 in. In the rear, the inlet orifice is 0.031 in. and the exhaust is 0.042 in. These larger orifices in the rear allow leveling at approximately the same rate as the front since a single valve controls both rear springs. These valves are position sensitive and operate either to admit or exhaust air from the springs as the spring length changes from design height. When the car is moving, the leveling valve's exhaust supercharges the line to the compressor inlet and is then pumped back into the high-pressure reservoir. When the engine is shut off and air is exhausted, as in passenger unloading, the air escapes from the system through a low-pressure blow-off valve set at 25 psi. This pressure is sufficient to prevent the escape of exhaust air during ride motions. An outside air intake valve provides for replenishment of the reservoir when a load is added. A check valve, built into each leveling valve, prevents back flowing in the air supply line, thus

preventing deflation of the spring when the car is inadvertently loaded with zero pressure in the reservoir.

Leveling Valve Action

A roller, riding atop the piston in the air spring, opens and closes the orifices in the valve, depending upon the length of the spring (Fig. 2). At design position both orifices are closed. The actual leveling valve has a zinc die-cast body and stamped steel valve levers. A common spring loads both valve levers against their seats. The orifices are incorporated in the valve seats and, because of their small diameter, only a slight spring force is required to hold these valves closed against air pressure in the line. Lugs on the inner end of the follower lever pick up tabs on the valve levers to open the valves around a common shaft. These tabs can be bent during manufacture to adjust the "dead band" or inactive portion of the leveling valve travel. A spring on the follower keeps the roller in contact with the piston top during ride motions.

To reduce the travel requirements of the valve levers, the follower is stopped from following the piston beyond 1.5-in. of wheel travel in rebound. This distance is beyond the normal wheel amplitude so that normally the roller and piston remain in contact. The natural frequency of the lever is high enough to maintain this contact during wheel hop. This feature also disconnects the leveling valve linkage from the suspension arm, preventing accidental damage to the valve if the rebound stops of the axle are removed in service.

Integral air spring and valve construction has many advantages. Several seals are eliminated. The valve operating linkage can be made relatively simple and light in weight since it is protected from exterior environments. This spring design can be set to length and checked as a complete subassembly prior to installation in the vehicle. Service can be performed by simply disconnecting the leveling valve lines, unscrewing the gland nut and removing the complete valve assembly through the mounting boss on the side of the air-spring reservoir.

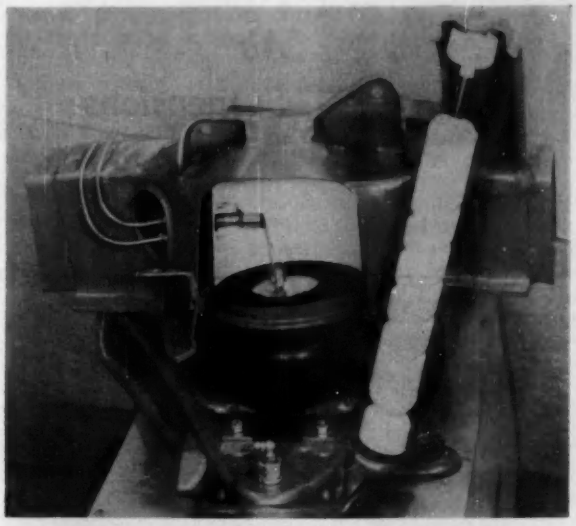


Fig. 2—Cutaway of air spring assembly showing leveling valve. Roller riding on top of piston opens and closes valve orifices, depending on length of spring.

The system's high-pressure reservoir has a volume of 360 cu in. and operates at 250 psi when fully charged. Enough energy is stored in the tank at 180 psi to level a 5-passenger load quickly with the engine shut off.

To prevent the icing of moisture introduced with make-up air, a simple alcohol evaporator has been added to the air intake.

Buick Air-Poise Suspension System

Based on paper by

Forest McFarland, Gail Peckham, and Eric Dietrich, Buick Motor Division, General Motors Corp.

BUICK'S "semiclosed" air-spring system provides a variable-rate suspension, automatic leveling and trim control, and manual lift.

The front air-spring construction embodies a diaphragm of 2-ply nylon, rubber-coated inside and outside, which fits into the outer rim of a metal container. The lip on its outer periphery seals it to the container in the manner of a tubeless tire. The inner ring of the diaphragm is clamped to the top of a piston-like member, which has a flat bearing at its lower end, contacting a spherical bearing located in the lower "A" frame. The rear spring, shown in Fig. 1, is similar in construction, but the inner portion of the rear carries a plug snapped into a hole in the top of a piston-like member carrying a bearing similar to the front.

Front air springs at design height have an area of 25 sq in. and volume of 300 cu in., while the rear springs have a 12 sq in. area and a volume of 235 cu in. Operating pressures, which vary with load, are in the neighborhood of 100 psi for a 5-passenger load, depending on car model.

Because the front springs act through a linkage of approximately 1.9/1, and rear springs act directly, front wheel rates are 71 lb per in. and the rear 81 or less depending upon the model at normal design height front and rear. Spring sizes result in a frequency of 43 cpm for the front and 52 cpm for the rear.

Operation of Control System

Air is supplied by a 2-cyl compressor, engine-driven through a V-belt at 1.15 times crankshaft speed, delivering air up to 290-psi stall pressure. A high-pressure storage tank of approximately 820 cu in. volume is located at the front of the chassis. From the storage tank, the air is conducted to a re-



Air Suspensions

Buick

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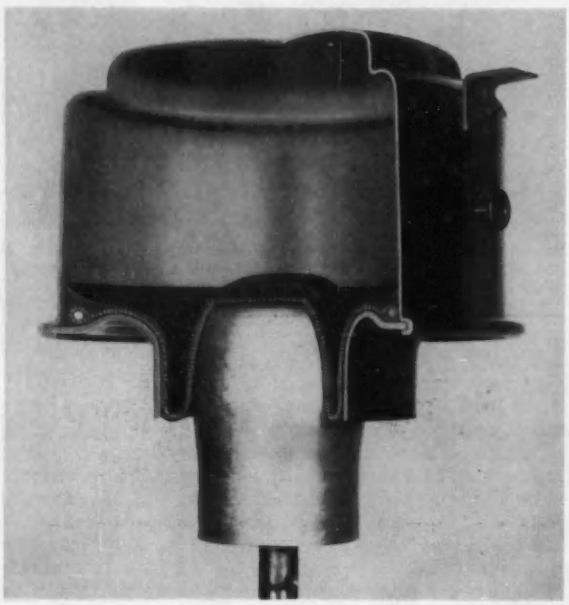


Fig. 1—Buick's rear air spring. Note 2-ply, rubber-coated nylon diaphragm, which fits into outer rim of metal container. Lip on its outer periphery seals it to container in the manner of a tubeless tire.

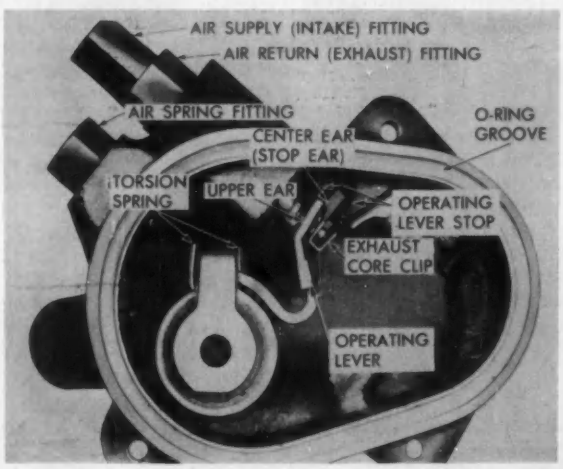


Fig. 2—Height control valve, of which there are three, consists of two spring-loaded, rubber-sealed valves, an inlet and an exhaust, operated by an arm connected to a shaft to the exterior.

ducing valve in the manual override valve set at 145 psi to maintain a constant pressure supply in the system. From the manual override valve the air passes to the height control valves.

The front height control valve is operated by a lever from the center of the stabilizer bar to obtain the average of the car height at both front wheels. A cross-flow valve, consisting of a double check valve, permits unrestricted airflow to either spring, but restricts flow from each to minimize cross-flow from one spring to the other under roll. Height control of the rear springs is similar only in that each spring has its own height control valve.

Air from the three height control valves returns to the manual override valve, then to the compressor inlet or to the air cleaner, depending on whether or not the compressor is running. Any make-up air required by the compressor when the springs are not exhausting is drawn in through the air cleaner connection. This results in a semiclosed system. Air is drawn from the center of the storage tank, the tank itself serving as a moisture accumulator. Any casual water collected is drained at time of lubrication.

Height Control Valve Design

The height control valve, shown in Fig. 2, consists of two spring-loaded, rubber-sealed valves—one inlet and one exhaust—operated by an arm connected to a shaft to the exterior. This shaft on the front valve carries an arm connected to a link fastened to an arm on the stabilizer bar; in the rear, the shafts are attached to arms, then to links, which in turn are attached to the rear-axle strut rods. When the car is too low, the inlet valves are opened; when too high, the exhaust valves are opened. Free play in the lever between the two valves permits a ±0.25-in. variation in car height at front and rear before the valves open. Control pressures are adequate to maintain car levelness with loads up to five passengers and 500 lb in the trunk.

Various airflow control mechanisms were developed and the design finally accepted consists of flow restrictions through 0.025-in. orifices protected by

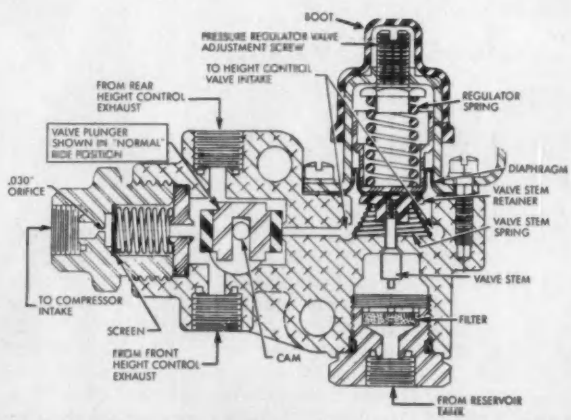


Fig. 3—Manual override valve enables driver to overrule normal function of height control valves and raise the car for abnormal road conditions. Pulling knob under instrument board lifts front over 4 in. and rear about 5½ in.

screens immediately ahead of them. The restrictions have been found satisfactory for rough road travel as well as leveling when passengers enter or leave the car.

Operation of Manual Override Valve

Incorporated in the manual override valve, shown in Fig. 3, is a pressure regulator valve set to limit air pressure past it to 145 psi. Air flows from this valve to the leveling valves and air springs, returning through the leveling valves to the low-pressure chamber and then through a 0.030-in. orifice to the compressor intake.

The manual override valve enables the driver to raise the car over 4 in. in front and about 5½ in. in rear, simply by pulling a knob under the instrument board. This operation causes a valve plunger in the override valve to shut off the exhaust line to the compressor and open the exhaust lines of the height control valves to the 145-psi air normally reaching the valves through the inlet valves only. This air raises the exhaust valves off their seats and fills the springs with 145-psi air, overruling the height control valves' normal function.

Two precautionary valves are supplied. A pressure relief valve set at 150 psi minimum is located in the low-pressure line to act as a safety valve should air pressure become too high in the override position of the valve due to leakage of the 145-psi reducing valve. Likewise, a compressor check valve in the high-pressure line prevents air from the storage tank backing up into the compressor and leaking slowly when the car is parked.

Ford

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tween fill and exhaust differential pressures. Where lines are under constant pressure, copper tubing is used, but where pressure is intermittent the tubing is of nylon.

Leveling Valve Control System

Three valves control leveling—one at each of the two front springs and the third controlling the two rear springs in common. The actuating levers are attached to the upper suspension arms in the front and to the rear-axle housing in the rear by readily adjustable links. Because these levers are attached to the unsprung mass, any deviations in car riding height at the points of attachment result in the levers rotating the leveling valve cams. If a height adjustment is needed while the car is being driven or is standing with doors closed, air is directed to or from the springs through highly restricted passages in the leveling valves so that change occurs slowly. When the doors are opened to let passengers enter or leave, a solenoid valve is actuated to open pneumatically a relatively unrestricted bypass in each leveling valve through which the springs are filled or exhausted as needed for leveling. Fig. 1 presents a cross-section of the leveling valve. The left portion of the valve controls normal leveling, the right portion controls fast leveling.

The valve body is an aluminum casting while all pistons are coated steel. This combination was found to give excellent life and a minimum of wear and scuffing. All seals are made of durable, leakproof, synthetic rubber materials. For manufacturing convenience the metered orifice valve is made of nylon with the 0.012-in. metering hole molded in the part. A fine wire 0.009 in. in diameter passes through the hole to serve the dual purpose of reducing its effective area and acting as a cleaning agent.

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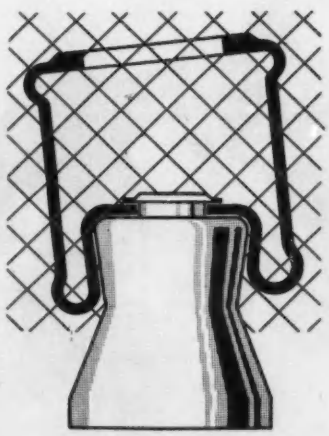
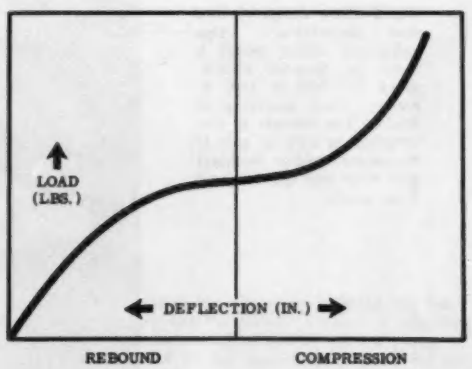


Fig. 2—Piston contour gives low ride rate in center of ride range. Diagonal cord angles in diaphragm fabric give strength in all directions.





Air Suspensions

Ford

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The solenoid valve, which serves to provide air at reservoir pressure for fast leveling, is actuated by dome light switches on the door hinge pillars. It also acts as a high-pressure relief valve, opening at 400 psi if the system pressure becomes abnormally high.

A restrictor valve isolates the two rear springs with regard to air transfer so as to provide adequate rear-suspension roll resistance. This valve is also triggered by high-pressure air from the solenoid so that the high restriction orifice is temporarily bypassed when fast leveling action is required.

T-check valves are provided between the leveling valves and air springs. These are low-pressure limiting devices to prevent the springs from exhausting below the set minimum value of 55–65 psi front and 25–35 psi rear. They also stop extreme leveling action, which would otherwise occur if one wheel were jacked up for tire change, and prevent total loss of air in the springs should a leak develop elsewhere in the system.

The front spring unit has four basic parts—rubber diaphragm, support sleeve or girdle, piston or pedestal, and upper seat and pipe assembly. The rear spring has, in addition, retainers at both upper and lower seals to prevent unseating if shock absorbers are removed or disconnected while the car is on a hoist.

A contoured piston and diagonal cord angles in the fabric layer of the rubber diaphragm are used to get a load-deflection curve nearer to the ideal and obtain ample diaphragm strength in all directions. Contouring makes possible changing the effective area, which is the major factor in determining the rate characteristics as the piston travels up and down in the rubber diaphragm. The hour-glass shape establishes an area-pressure relationship giving a low ride rate in the center of the ride range, as shown in Fig. 2.

Suspension Structural Components

It was possible to apply air springs to the front suspension, using conventional upper and lower arms with minor modifications, and still have them suitable for either coil or air springs. The rear suspension is completely new. Fig. 3 shows the new design. It is of the trailing-arm type with several unusual features. One is the forward attachment to the frame; instead of the usual transversely mounted rubber journal bushing, it uses a large spike-end rubber mount. This practically eliminates torsional loading in the trailing arm. It permits rather large axial, but only small radial deflections, and it contributes greatly to the reduction of harshness without affecting rear-end steering adversely.

The trailing-arm rear mounting consists of an arm attached to the axle by a pair of transverse rubber bushings whose axes are spaced approximately 5 in. apart. This gives effective isolation yet ties the axle and trailing arms together in such a way as to constitute a roll-stabilizing unit with the axle housing acting as the torsion member. To provide lateral stability in this rear suspension, a track bar is attached to the left frame side rail behind the axle and to the right side of the axle housing near the right air spring. Both ends of the track bar are attached to brackets by means of rubber insulators.

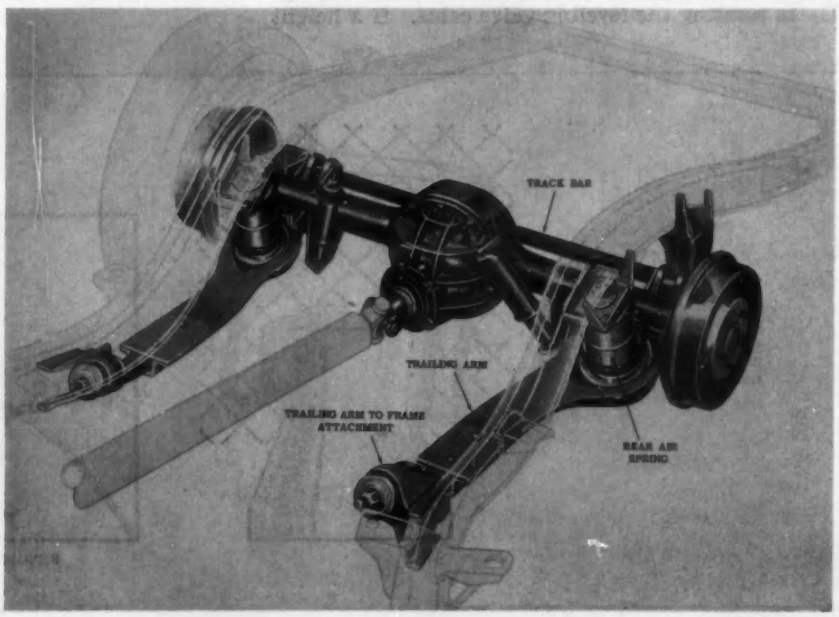


Fig. 3—New design of Ford rear suspension. Large spike-end rubber mount is used for forward attachment of trailing arm to frame. Rear mounting of trailing arm consists of arm attached to axle by pair of transverse rubber bushings with their axes spaced about 5 in. apart.

Oldsmobile

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operate at 100 psi. Basic design is alike for front and rear, but configuration differs because of space limitations and to provide the necessary spring stroke. Spring volume at design height is 295 cu in. in front and 240 cu in. in the rear.

The springs have a variable rate. This is shown by the heavy line of the load-deflection curve in Fig. 2. Slow movements are possible in the normal ride range because the air-spring rate is approximately 60% of the conventional steel spring. But as the wheel travels farther into compression and rebound, the spring builds up rate rapidly to absorb the energy created by severe bumps or dips in the road.

In the diaphragm-type spring, rate is a function of effective area and is controlled by guiding the diaphragm mechanically between the lower ring of the air chamber assembly and the piston as shown in Fig. 3. The letters A, B, and C represent the spring in its normal position, full compression, and full rebound positions, and the change of effective areas which determine the rate characteristics of the spring.

Three height-control valves maintain the car at constant trim height regardless of load. Two valves are used at the rear, one located near each rear spring, with actuating arm connected to the suspension by a short rubber insulated link (Fig. 4). Rear height adjustment is made by turning an eccentric in the actuating arm. One valve, centrally mounted at the front of the chassis, is actuated by a linkage arrangement from the front stabilizer bar. This linkage also has the eccentric design for height adjustment. Small orifices in each valve restrict the flow of air to and from the springs, thereby permitting inlet and exhaust valves to function without a delay mechanism or dashpot effect.

A check valve tee is used in conjunction with the single front height valve which controls the two front springs. This tee permits full flow of intake air to the springs as the ball checks move from their seats, while exhaust air from the springs must pass through small orifices in the ball check seats. This prevents free flow of air from spring to spring while providing a restricted intercommunication to enable springs to equalize in pressures in a relatively short time.

Engine-Mounted Air Compressor

The air compressor is a 2-cyl, V-block design having a displacement of 5 cu in. per compressor revolution. It drives from the engine with a pair of matched belts and the compressor crankshaft end is extended to the rear to drive the power-steering pump rotor. A lubrication pump incorporated in the compressor design takes oil from the power-steering pump reservoir.

An oil and moisture separator (Fig. 5) is mounted on the chassis below the compressor, connected to it by flexible high- and low-pressure hoses. The unit contains a high-pressure check valve and low-pressure cutoff valve designed to prevent loss of air

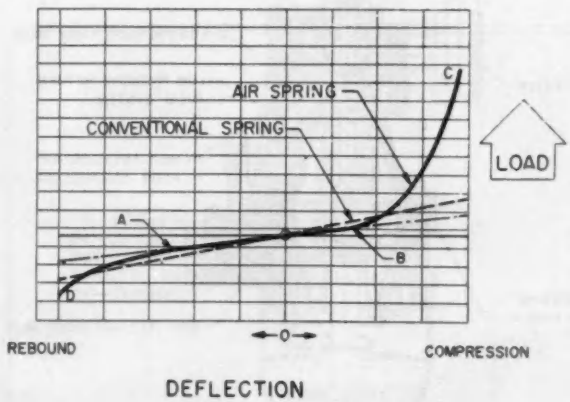


Fig. 2—Variable rate of diaphragm-type springs is shown by the load-deflection curve. The air-spring rate is approximately 60% of the conventional steel spring.

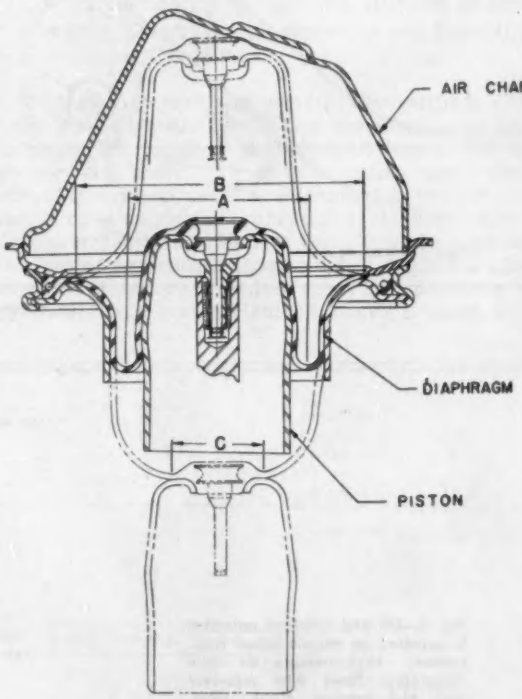


Fig. 3—Rate is controlled by guiding the diaphragm between the lower ring of the air chamber assembly and the piston. Change of effective areas which determine rate characteristics of the spring are shown by lettered positions, A for normal, B for full compression, and C for full rebound.



Air Suspensions

Oldsmobile

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back through the compressor when the engine is not running. Added features of this unit are a low-pressure system blow-off valve, and filtering valve at the fresh air intake port. A sediment drain at bottom of the separator bowl facilitates servicing.

Closed Air System

An extra large high-pressure tank, mounted on the right rear of the chassis, stores the filtered air from the compressor until needed by the height control system. A tire valve fitting is located at the rear of the tank for recharging the air in the system and pressure checking in service. This valve also connects with a rubber hose inside the tank, which acts as a siphon to drain off any moisture. The closed system, which uses a low-pressure tank to collect air exhausted from the springs and stores it for re-use in the high-pressure system, minimizes the need for fresh air and reduces the liability of contamination from moisture and dust. Maximum pressure in the low-pressure system is limited to 70 psi by the blow-off valve in the oil separator. Protection against over-inflation of air spring assemblies is given by limiting pressure to 150 psi with a regulator valve in the elevator valve assembly.

A manual control in the elevator valve assembly enables the driver to raise the car about 4 in. higher than normal if necessary. When the elevator lever on the instrument panel is released, the car returns to normal height automatically.

All air pipes in the system are copper for rust protection. All air line fittings are sealed in rubber to prevent leaks from shock and vibration. Air line connections use a beaded pipe end with a long pilot into the fitting. A rectangular section o-ring fits onto the tube end and in a cavity of the fitting to provide a positive air seal.

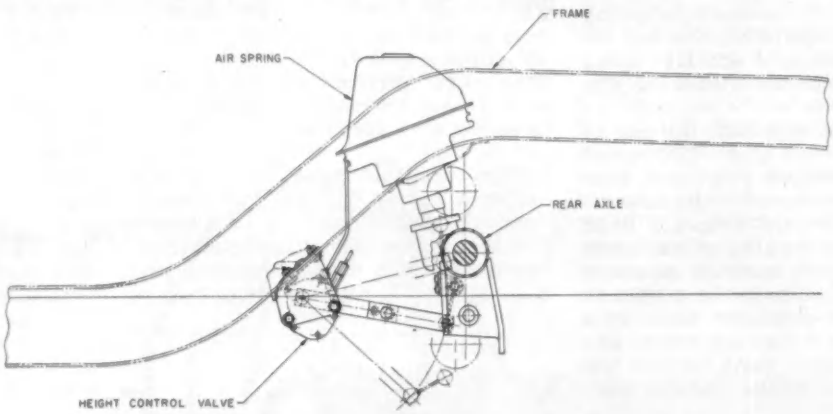


Fig. 4—One of the two rear height control valves with actuating arm connected to the suspension by a short rubber insulated link.

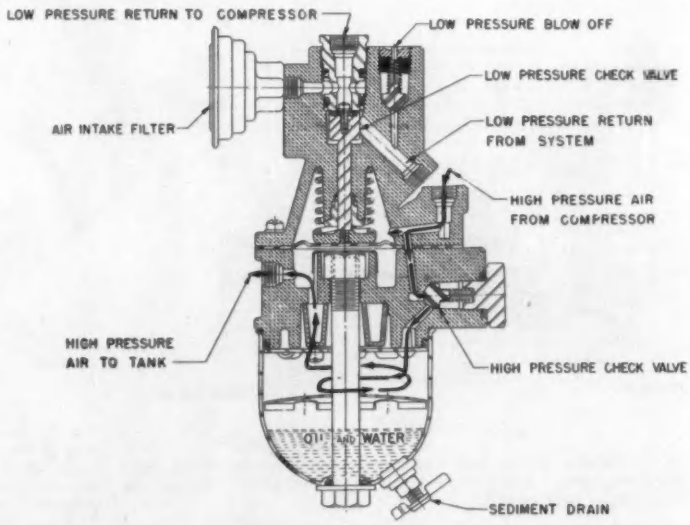


Fig. 5—Oil and moisture separator is mounted on chassis below compressor. High-pressure air from compressor flows into separator past high-pressure check valve, through filter bowl and filter, before entering high-pressure storage tank.

7 Jobs for the *Airborne Computer* in Aircraft Navigation and Control

Based on paper by

Edward L. Braun and Geoffrey Post
Litton Industries

1. Navigation Based on Aircraft Instrument Inputs

Digital computers are being used to provide dead-reckoning navigation based on data derived from conventional instruments which provide information as to true airspeed, altitude, and compass heading. Since computations based on these data are subject to appreciable error because of wind effects, an aided tracking scheme is used which allows a wind velocity to be entered into the computation automatically by a process which only requires the navigator to keep cross-hairs centered on an aim point, sighted through a periscope or on a radar P.P.I. display. Dead-reckoning computation from this point on to the next time of determining wind velocity is corrected by the value of wind velocity thus computed. To prevent the errors inherent in dead reckoning from becoming excessive, means are provided for correcting computed position by sighting on a number of check points during the course of the flight.

2. Inertial Navigation

An inertial navigation scheme offers the following advantages:

- Great inherent accuracy.
- Complete self-containment.
- Independence of weather conditions or time of day.
- Independence of vehicle's altitude or speed.
- Invulnerability to detection or jamming in military systems.

In this navigational system the outputs of accelerometers, which sense minute changes of translational acceleration, afford the means for computing position by a double integration process of which an important requirement is the establishment of a reference coordinate system. The coordinate reference, known as a "stable platform," is a set of gyroscopes suspended in a gimbal system capable of relative freedom from the airframe. The gyroscopically stable element allows a fixed, prede-

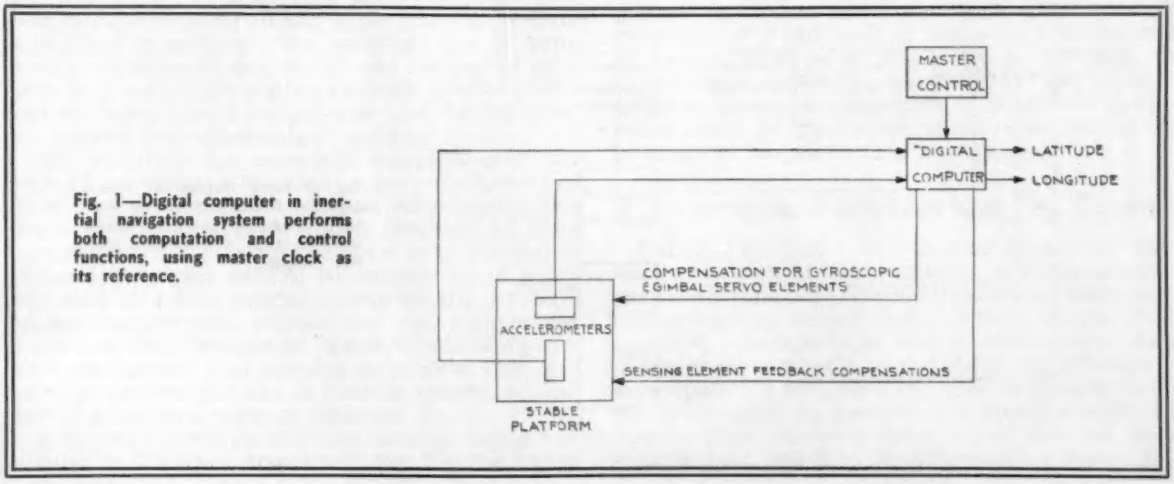


Fig. 1—Digital computer in inertial navigation system performs both computation and control functions, using master clock as its reference.

termined orientation in space, while a controlled gimbal servo system firmly establishes a stable reference.

A digital computer performs both computation and control functions in such a system, using a master clock as its reference (Fig. 1). These functions are:

- Computing the present position of the vehicle by "driftless" integration.
- Retaining an accuracy of computation to the order of 1 in 100,000.
- Converting the reference-sensed data coordinates into earth surface coordinates.
- Computing special compensation feedback corrections for the accelerometers and the gyro gimbal servo systems.
- Limiting acceleration commands to the autopilot where required for airframe safety.

In most systems concern is with error growth in the low-frequency end of the system band pass. If flight lasts several hours, a record can be kept of the navigation system's parameters and the information processed by a digital computer to produce corrective terms for the control system. The digital computer's advantage for these functions derives from three essential requirements:

1. Corrective functions are in general nonlinear and also involve logical decisions.
2. Corrective functions require a fair amount of data storage.
3. Overall system accuracy requirements exceed those obtainable from analog computation.

3. Doppler Navigation

This system employs the so-called Doppler effect to determine the relative motion of moving objects. Thus, a shift in frequency proportional to the closure or recession velocity of these objects is produced. Then, the input data, a velocity function, must be integrated to produce position information. These data are also frequency-time measurements and are thus available as pulse trains regardless of whether a continuous wave or Doppler system is used. Hence it allows for simple compatibility with a digital computer.

The advantage of a Doppler system is its combination of relatively good accuracy, resolution, and freedom from many troublesome radar "noise" problems. The disadvantage is mainly its lack of position reference capability, which suggests that it should be used in conjunction with another system, such as inertial navigation, for optimum performance.

4. Navigation Based on Hyperbolic Navigation Aids

In a hyperbolic navigation system the position of the aircraft is determined by the intersection of two hyperbolas. The aircraft is located on one hyperbola by the difference in arrival times of radio-frequency pulses from one pair of ground stations, and on the other by the time difference of pulses arriving from another pair of stations. Only three ground stations are needed, one master and two slaves. A digital computer is particularly well suited for such a system because the error in position determination is proportional to the error in time measurement of the arrival of pulses from the ground stations. A digital scheme of time difference measurements must be used for accuracy and a digital computer is best suited to receive such measurements.

5. Automatic Flight Control

The automatic pilot is designed to hold the aircraft on any predetermined flight course, to change this course at will with an exact coordinated turn, or to maintain the aircraft laterally level, or in any desired angle, climb, or dive.

Self-contained vertical gyros establish a flight reference for lateral and longitudinal axes of the aircraft with respect to a gravitational reference, while a directional gyro establishes an azimuth heading with respect to magnetic north. The spin axes of the gyros are maintained level to the earth's

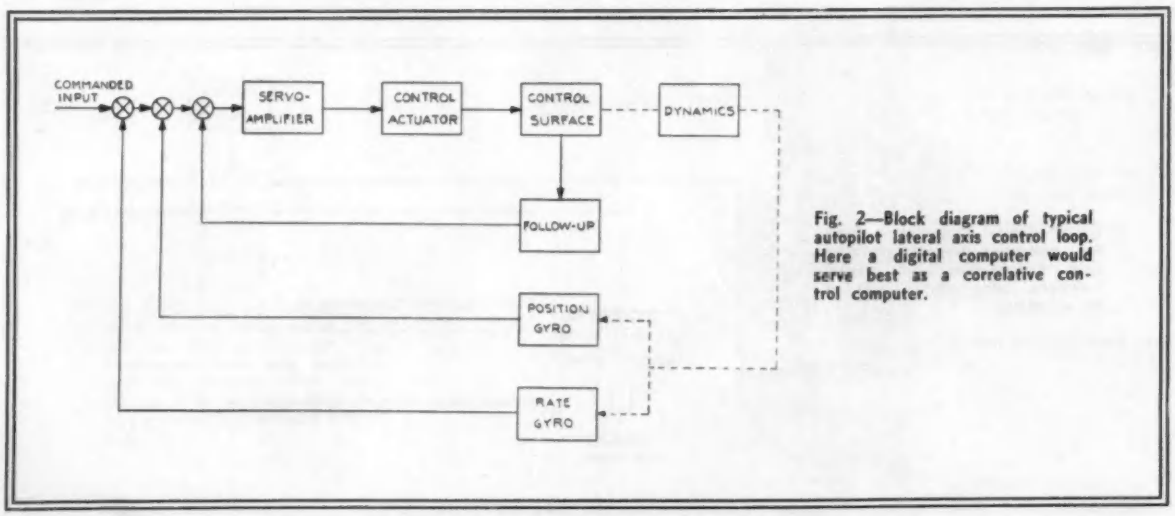


Fig. 2—Block diagram of typical autopilot lateral axis control loop. Here a digital computer would serve best as a correlative control computer.

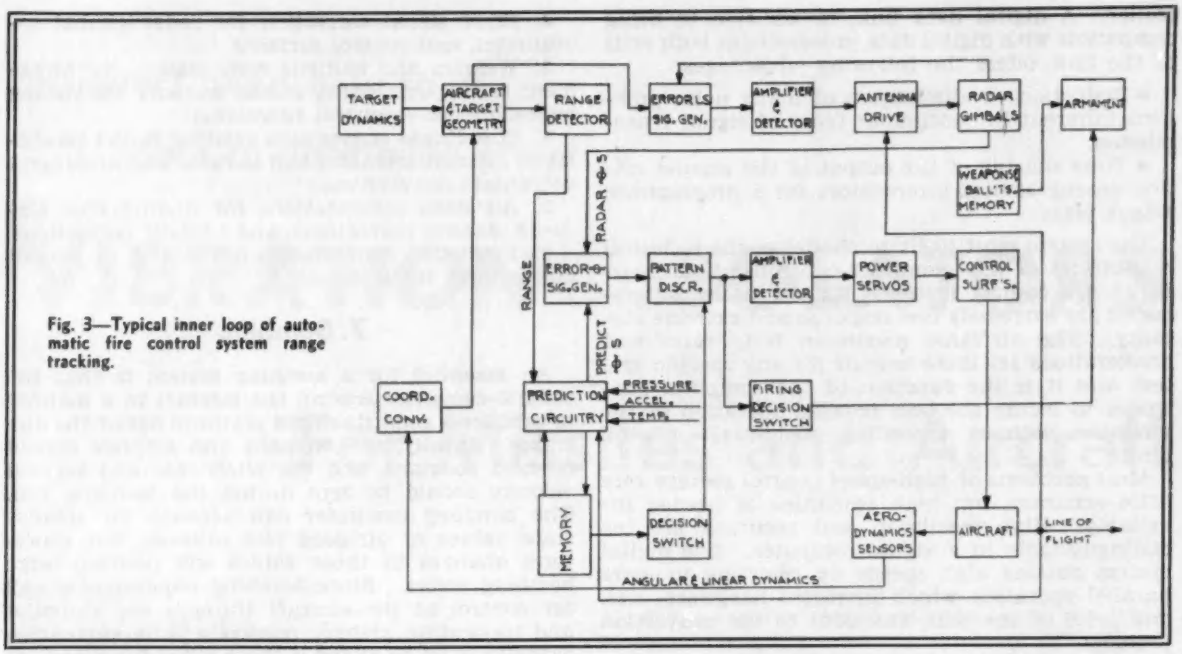


Fig. 3—Typical inner loop of automatic fire control system range tracking.

surface by such means as liquid level switches and the like. With this type of sensing, control is applied through the three rotational axes of the air vehicle, namely pitch angle, yaw angle, and roll angle, and their respective rates.

At subsonic speeds these latter control parameters are fairly sufficient, but external disturbances in the longitudinal axis generate two oscillatory motions for fixed controls. The first is a low-frequency, lightly damped oscillation called the phugoid, and the second is a relatively high-frequency, fairly well damped oscillation known as the short period. Then there are three characteristic lateral oscillations—the spiral divergence or convergence, the roll subsidence, and the Dutch roll.

All these modes are considerably modified at supersonic speed and oscillations may be in the form of nonlinear divergent modes which may be coupled with subsiding ones. New phenomena such as: tuck under, pitchup, wing drop, supersonic yaw, and inertial coupling all add to the problem of flight stability. In addition, the couplings due to aeroelastic airframe modes, which add degrees of freedom to the airframe control problem, make it mandatory that a digital computer be used for the overall control and computation problem.

The dynamics are especially complicated in the case of aeroelastic coupling at supersonic speed and it is desirable to determine just what parameters are unstable and apply adequate feedback for their neutralization. This can be done by a correlative scheme of varying control parameters in all possible simulated loop configurations within the computer memory and establishing the stabilization rates and their tendencies. Then, by resetting control parameters, it is possible to achieve the optimum or best compromise of stabilized mode, according to a required response criterion.

A typical controlled autopilot channel would look similar to the block diagram in Fig. 2. The digital computer in such a system would be best utilized as a correlative control computer. In this regard its functions include:

1. Mating stabilization and response over the entire band of airframe control frequencies including the very slow- and high-speed modes of lateral and longitudinal oscillation as well as aeroelastic modes.
2. Computation of nonlinear control parameters such as gains and response characteristics. For example, there is the problem of determining, for a step input, the fastest stable response that can be achieved with minimum overshoot (the so-called optimum servo problem). This requires close dynamic control of acceleration, velocity, and position, and is a variable under many conditions so that adequate control requires computer speed and correlation.

During the transient period between two steady-state conditions, a flight controller must effect a requested operation consistent with other desired conditions of flight, and at the same time prevent the system from being overloaded in any way. A digital flight controller can perform the required linear or nonlinear computing to determine operational limits on the system at all times within the accuracy of the measuring instruments.

6. Interceptor Vectoring and Fire Control

A digital computer can be used to process data from a network of radar stations in an air defense control system. The computer generates flight path instructions to interceptors. Characteristic data on these interceptors as well as radar input data can be made available to the computer, allowing it to compute the best path and rate of climb to bring the interceptor in position for contact with the target. This vectoring data can be coupled via a suitable data link into the interceptor's flight con-

troller. A digital data link, in addition to being compatible with digital data processors at both ends of the link, offers the following advantages:

- Reduction or elimination of many noise problems inherent in continuous types of signal transmission.
- Time sharing of the output of the ground station among several interceptors for a programmed attack plan.

The system most likely to challenge the technical capabilities of any computer-controller is the airborne fire control system. Its two basic requirements are extremely fast response and extreme stability. The airframe maximum body rates and accelerations set these bounds for any specific system and it is the function of the computer-controller to insure the best possible operation of the airframe without exceeding structural or stall limits.

Most problems of high-speed control require very little accuracy, but high resolution is needed inevitably. High resolution and accuracy are indistinguishable in a digital computer. The digital system obtains high speeds by resorting to more parallel operation which increases hardware, size, and price of the unit, and adds to the conversion problem.

A digital computer can be used for the following major functions as abstracted from the basic fire control operating diagram (Fig. 3):

1. Automatic range tracking, including range, range rate, and automatic target acquisition.
2. Error signal correction for radar gimbal coordinates, and control surfaces.
3. Weapon and ballistic computation for armament setting (requiring special memory for storing miscellaneous empirical functions).
4. Coordinate conversions relating target geometry to aircraft geometry and to radar and armament coordinate conversions.
5. Air data computations for finding true airspeed, density corrections, and ballistic corrections.
6. Prediction computation of collision or pursuit curve flight trajectories.

7. Bombing

An essential for a bombing system is that the control-computer control the aircraft in a manner to produce a good stabilized platform out of the airframe. Ideally, the airspeed and altitude should be held constant, and the pitch rate and vertical velocity should be zero during the bombing run. The bombing computer can account for steady-state values of airspeed and altitude, but short-term changes in these values will produce large bombing errors. Since bombing requirements call for control of the aircraft through the autopilot and navigation system, relatively little computing capacity must be added if these other functions are provided. The required control bandpass for bombing is slow and similar to navigation.

To Order Paper No. 204 . . .
. . . on which this article is based, turn to page 5.

Rocket Engines Use LOX . . .

. . . because liquid oxygen is easy to get and easy to handle.

Based on talk by
Floyd F. Twight,
Rocketdyne Division, North American Aviation, Inc.
(presented before SAE Southern California Section)

ROCKET engines are using liquid oxygen (LOX) as an oxidizer because of its ease of manufacture, storage, and handling, its low cost, and its plentiful supply. Stability against detonation and mechanical shock, except in the presence of contaminating materials, are also prime advantages.

From the performance side, the theoretical specific impulse of some fuel-LOX combinations are:

Ethyl silicate	245
75% ethyl alcohol	248
Methyl alcohol	252
Nitromethane	253
92.5% ethyl alcohol	256
Nitropropane	257
Isopropyl alcohol	259
Propylene oxide	260
69.5% propylene oxide / 30.5% ethylene oxide	262
Ethylene oxide	262
JP-4	264
RP-1	266
88% ethylene diamine	264
Turpentine	265
Ammonia	266
Methyl cyclopentane	265
h-octane	268
Diethylenetriamine	269
Methylamine	272
Methyl acetylene	273
Unsymmetrical diamethyl hydrazine	276
Hydrazine	262
Hydrogen	364

Metals suitable for contact with LOX are: aluminum alloys, stainless steel, nickel alloys, copper alloys, monel, and iconel. Carbon steel and cast iron are not acceptable.

Lubricants considered safe from an impact sensitivity standpoint are Molykote, Type Z (powder), and a suspension of graphite in Aeroclor 1254.

Teflon and Kel-F are two plastics in common use as seals for valves, pumps, and piping for LOX. Mylar may be used for specific low mass quantity applications, due to its impact sensitivity when in contact with LOX.

Solvents for cleaning and flushing LOX systems include: chloroform, Oxylene & Turio 4441, methylene chloride, and trichloroethylene. This latter is recommended from a cost, detonation, storability, and availability standpoint.

Designers need easy-to-use data to determine effective

VIBRATION ISOLATORS

For Missiles and Aircraft

Based on paper by

Sheldon Rubin,

Lockheed Aircraft Corp.

THE right combination of four properties in an isolator permits it to link equipment safely to the driving motion of a supporting airplane or missile structure. So, when a designer finds he cannot directly mount delicate equipment, he must examine isolators for their:

- Stiffness and damping performance.
- Load and deflection characteristics.
- Strength and endurace.
- Resistance to environment.

To do this, he has to get data for each property from the isolator manufacturer. And he has to get it in a form that facilitates easy calculation of the protection to the equipment.

Dynamic Stiffness and Damping

To simplify calculations, the data on damping and stiffness should be presented in a linearized form. This means the isolator can be represented as an impedance between the airframe and equipment. Also it implies that the impedance is constant at each frequency. A yardstick is needed to tell if an isolator closely approached this assumption. Fig. 1 shows the use of transmissibility as such a measure.

When linearized, the isolator can be represented by linearly elastic springs, viscous damping elements, and mass. The designer can use this information directly if he is given the location of the springs and dampers and their constants or coefficients.

Location information is most conveniently given by elastic and damping centers and their principal axes.

An isolator's elastic center is the point which, when acted upon by a static force, will give a pure translation motion to the suspended equipment, and at which a static torque will give pure rotational motion. Damping center is similarly defined and is often identical in location to the elastic center.

Principal axes for damping and stiffness pass through their respective centers. They also have the property that a steady force applied along the axis results in a like-directed displacement.

To round out the information needed, the translational and torsional spring constants along each principal axis and corresponding viscous damping coefficients should be given as force per unit deflection and force per unit velocity, respectively.

Any torsional effect from the translational springs is negligible, provided the torsional stiffness of the isolator is small compared to the product of the

This is a progress report of the Isolation Systems Subcommittee of SAE Committee S-12 on Shock and Vibration. It supplements a previous report that appeared in the March, 1957, issue of SAE Journal.

Members of the Subcommittee are:

G. Harold Klein, chairman, Ramo-Wooldridge Corp.

L. N. Foglesong, Barry Controls

C. P. Haber, Lord Mfg. Co.

Dr. Sheldon Rubin and J. Rebman, Lockheed Aircraft Corp.

Thomas Peratis and C. H. Michel, George W. Ledbetter & Associates

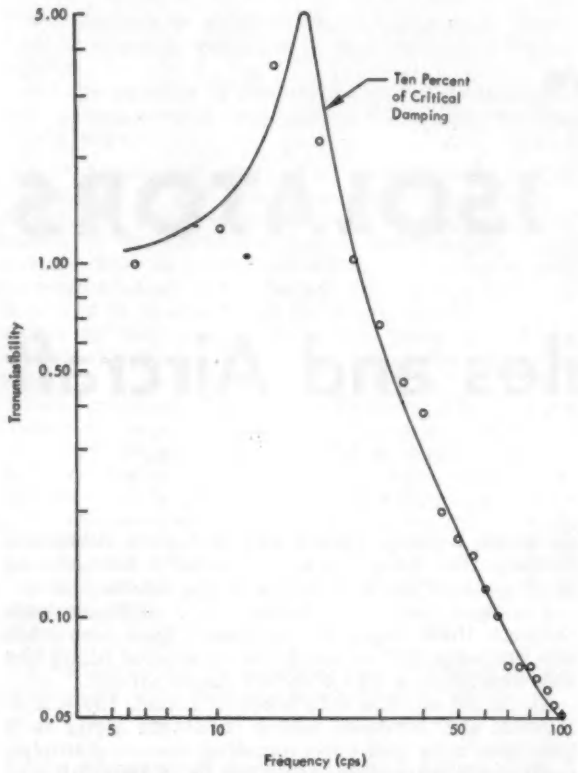


Fig. 1—Isolators which can represented by a linearizing approximation can be spotted by plotting transmissibility against frequency. The solid line is a linearized simplification of an actual isolator. The circles are actual test points.

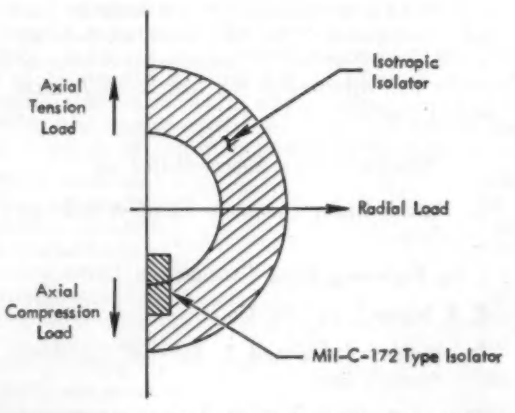


Fig. 2—Examples of convenient plotting of isolator load range data.

translational spring constant and the square of the distance between the elastic center and the center of gravity of the equipment.

Load and Deflection

Protecting equipment from shock and vibration is not enough. The isolator must also support the dead load in a way that makes best use of its vibration isolation properties.

The key to getting the right isolator for a job is the load deflection curve. This curve will show the linear area of operation of the isolator as well as earmark any snubbing action. An indication of isolator stiffness can be gotten from the slope of the curve.

The direction of applied loads must be spelled out. An example of how this can be done graphically is shown in Fig. 2. With this information the designer can determine the effectiveness of the isolator in all the required airplane or missile attitudes.

Strength and Endurance

A uniform method of comparing fatigue properties of isolators is needed. An exacting test will involve tremendous amounts of testing. A simplified technique would be to prove isolators by vibrating them at resonant frequency and fixed amplitude for a prescribed time. Shock load ratings could be accomplished in a similar way by exposing the isolator to repeated high g shocks of short duration. A military specification now calls for 15g shocks of 11-millisec duration.

Ultimate and yield strengths can be evaluated by the dead load held before failure. These strengths can also be estimated from the shock loading tests.

Environment

The designer will want answers on one or more of the following to insure the proper performance of an isolator in the expected service:

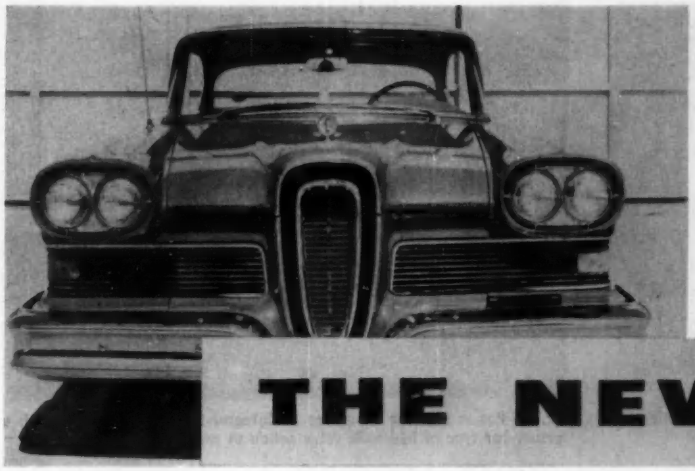
- Temperature ranges over which the isolator will malfunction or completely fail, including soaking time to failure.

- Resistance to aging in service and on the shelf. This information should be given in terms of deviation from design performance.

- Creep rate under rated load. This could be recorded as the change in isolator deflection per unit time under the maximum rated load at a given temperature.

- Resistance to surrounding conditions, such as salt spray, electrolytic corrosion, sand, dust, humidity, fungus, oils and fuels, corrosive vapors, sunshine, and nuclear radiation.

To Order Paper No. 197 . . .
. . . on which this article is based, turn to page 5.



Abridged from an

SAE Detroit Section Paper

THE NEW EDSEL

Based on paper by

Neil L. Blume

Ford Motor Co.

FORD Motor Company's new Edsel is being produced in two wheelbase lengths, powered by 90-deg, V-8 overhead-valve engines with 10.5/1 compression ratio (Table 1), and with a steering-wheel mounted, fail-safe, pushbutton shift.

Other features of the new car include:

- Single-control ventilating system.
- Power steering with torsion-bar hydraulic valve action.
- Water-warmed intake manifold.
- Dual-range transmission.
- Automatic brake adjuster.
- Air level ride suspension (extra equipment).

Drive controls for the "Teletouch" pushbutton shift are located in the center of the steering wheel, the buttons being depressed below accidental strike distance. A positive feed is used in contrast to a grounding system such as is customarily incorporated in horn circuits. This feed causes the system to remain in whatever position selected, even in case of accidental grounds. A dual switch, operated by transmission hydraulic pressure, inhibits the selection of "reverse" above 15 mph and "park" above 3 mph. This provides for sufficient "reverse" speeds to permit rocking the car out of mud holes, but prevents engaging in "reverse" at high forward speeds. The 3-mph inhibition in "park" prevents damage to the transmission by accidental pressing of the "park" button at high forward speeds. The "park" position can be actuated after ignition is turned off, but no other position can be actuated until the ignition is turned on.

Single-Control Ventilating System

The rotation of a knurled bezel on a dial brings into play an electric servo unit, which actuates the valves for heating, defrosting, or ventilating. The heart of the system is a gear-driven control plate with pre-programmed cam grooves on one side and electrical contact surfaces on the reverse. Rollers, connected to actuating arms and bowden wires, ride in the cam grooves and are positioned in their proper location in the grooves by the clockwise or counterclockwise rotation of the control plate. The direction of rotation is determined by a pressure arm which rides on the electrical contact surface of the plate. Fig. 1 shows the servo operating the control for vent air. When the knob is rotated manually, the pressure arm makes a contact on one side of the contact plate, causing current to flow through one field of the servo, thus rotating the motor in one direction and operating the control plate.

Power Steering Described

The integral-type power steering gear features a torsion-bar type of hydraulic valve actuation to provide positive road feel. The gear consists basically of a gear reduction unit (recirculating ball and nut type), a power cylinder, and a hydraulic servo-con-

Table 1—Specifications for 90-deg V-8 Overhead-Valve Engine for Edsel Models

	Model E-400	Model E-475
Displacement, cu in.	361	410
Bore and Stroke, in.	4.05×3.50	4.20×3.70
Bore/Stroke Ratio	1.16	1.135
Maximum Bhp at 4600 Rpm	303	345
Maximum Torque, ft-lb	400 at 2800 Rpm	475 at 2900 Rpm
Compression Ratio	10.5/1	10.5/1

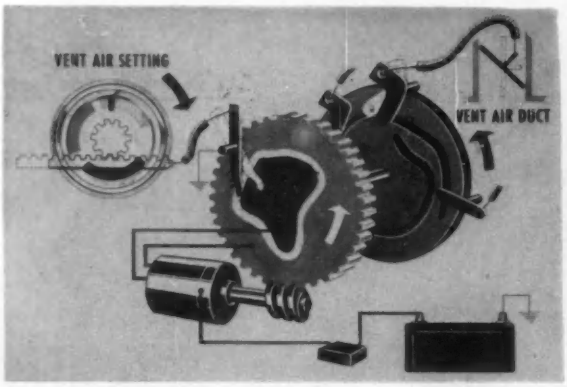


Fig. 1—Mechanism for single-knob control of heating, defrosting, and ventilating.

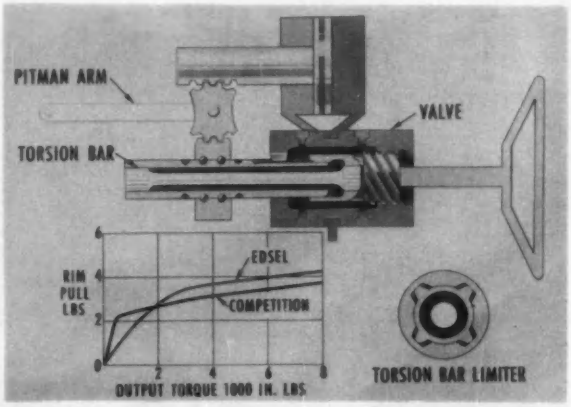


Fig. 2—Power steering comprises an integral-type steering gear with a torsion-bar type of hydraulic valve action to provide positive road feel.

trol valve (Fig. 2). The hydraulic valve, valve sleeve, and torsion-bar assembly are mounted on the end of the worm shaft and operated by twisting action of the steering shaft on the torsion bar.

The torsion bar is restrained from twisting more than 9 deg either side of normal to prevent overstressing the bar and to permit manual steering. The valve spool moves 0.004 in. for each degree of twist of the torsion bar and approximately 0.036 in. for maximum 9-deg twist. The valve must move 0.008 in., resulting in a 2-deg twist of the torsion bar for initial power assist. In normal straight driving, 0.5–1 lb of pull is required on the wheel to control the car. Cornering effort is 2–3 lb and maximum parking effort 4–5 lb.

Water-Warmed Intake Manifold

On the E-475 engine, engine water is run from the rear of both heads under and along the intake manifold passages. This water-warming of the intake manifold is the first stage of a 3-stage, parallel-flow cooling system. In this stage, water circulation is confined to the cylinder heads and intake manifold until a water temperature of 140 F is reached. At this temperature thermostats open in each bank of the cylinder block and the second stage begins. When the temperature reaches 180 F, a thermostat in the water outlet connection opens and circulation is now through the whole cooling system.

Dual-Range Transmission

The new dual-range transmission allows the option of starting in first or second gear and provides for smoother shifts into high gear automatically at speeds which are dictated by throttle opening.

The transmission (Fig. 3) is basically a 3-element torque converter in combination with a Ravegnaux (compound) planetary gearset, which provides three forward speeds and one reverse. The major innovation is the substitution of a sprag-type, one-way clutch to be the reaction member of the planetary gearset in the first gear. The shift from first to second gear can be made smoothly since a shift off a one-way clutch is smoother than one in which two bands are involved. With the one-way clutch, the timing problem of two bands disappears. A further aid to smooth 1–2 shifting is the addition of a hydraulic accumulator to the front servo, which assists in smooth application of the front band.

Automatic Brake Adjuster

Fig. 4 shows the Edsel automatic brake adjuster, which is designed to eliminate periodic brake adjustment and to permit lowering the brake pedal in closer relation to the accelerator pedal.

The adjuster maintains approximately 0.010-in. clearance at all times by adjusting the brakes whenever lining wear exceeds 0.005 in. All adjustments are made on reverse braking to eliminate the possibility of over-adjustment caused by drum distortion on panic stops in forward braking.

Essentially the installation comprises a control cable fastened to the anchor pin at one end and to the adjusting lever at the other. The cable is routed over a guide attached to the shoe web so that any shoe movement, beyond the predetermined brake adjustment, will lift the adjusting lever. When lining wear exceeds 0.005 in., the shoe movement will raise the adjusting lever until the next tooth is engaged on the adjusting sprocket. After releasing the brakes, the adjusting spring will rotate the screw resulting in the brake adjustment.

Air Level Ride Suspension

The air suspension (available as factory-installed extra equipment) has three principal features: the air springs, leveling valves, and trailing arm rear suspension. Compressed air, used both as the spring medium and as the means for height control, is supplied by a single-cylinder, 2.71 cu in. unit, driven at approximately engine speed and lubricated by engine oil. Balance pressure is approximately 300 psi; maximum power requirement about 1 bhp. The compressor delivers air through a flexible hose and check valve to a 400 cu in. reserve tank mounted in the right fender just aft of the headlamp.

Most of the air taken from the reservoir is consumed in supplying the springs; for this function the air passes through a copper line to a regulator valve, thence at reduced pressure (150–160 psi) to the three leveling valves and from them to the springs. Air at reservoir pressure is also supplied

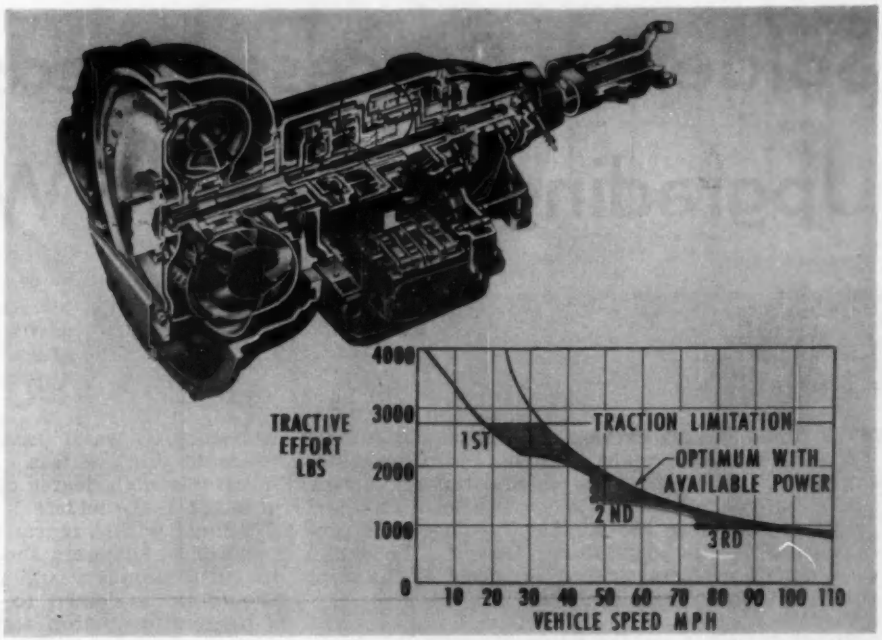


Fig. 3—Dual-range transmission provides option of starting in first or second gear.

for a triggering function, in this case fed to a door-controlled solenoid valve and from there by nylon lines to fast-action mechanisms in the three leveling valves.

This arrangement provides a "slow-fast" continuous height control. When height adjustment is required while the car is being driven or standing still with doors closed, air is directed to or from the springs through highly restricted passages in the leveling valves so that height changes slowly. When a door is opened and passengers enter or leave the car, the solenoid valve is actuated to open a relatively unrestricted bypass pneumatically in each leveling valve through which springs are filled or exhausted. This leveling operation is shown in Fig. 5.

Body Structure

Lower, longer, and wider bodies, featuring larger glass areas with longer and thinner surrounding framework, provide less opportunity to induce loading in the roof. The "dog-leg" characteristic of the roof supports, part of the price of the wrap-around theme, aggravates the problem. Thus, the tendency is for the roof to carry, as the upper chord member, less than its potential share of the loads imposed on the body truss.

In the Edsel line, the 118-in. wheelbase Ranger-Pacer series and the 124-in. wheelbase Corsair-Citation series, this adverse structural effect of styling has been largely offset by the use of heavier stock in front and rear pillars, a liberal use of gussets and bulkheads, and boxing of the roof rails. Laboratory tests show that in overall torsional stiffness, the 4-door hardtop is practically equal to the standard 4-door and only slightly less rigid in bending.

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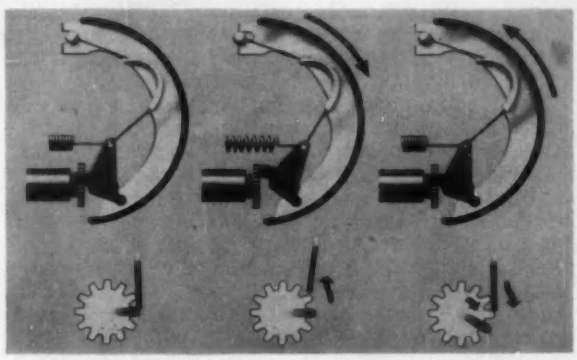


Fig. 4—Automatic brake adjuster eliminates need for periodic brake adjustment.

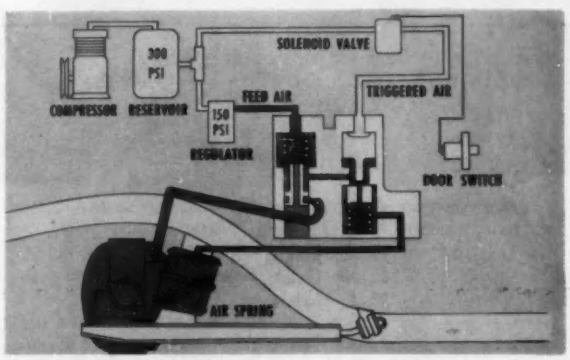


Fig. 5—Air-suspension leveling operation gives slow height adjustment when car is in motion, fast adjustment when a car door is open and passengers are entering or leaving.

Soldering Process Needs Upgrading for Missile Work

Based on secretary's report by

C. O. Stump

Rohr Aircraft Corp.

THE research and development phases of missile programs have revealed that standard engineering and quality process sepcifications covering solder joints are inadequate for missile work. As a result, a complete reevaluation of soldering processes has become mandatory. Here is a discussion of soldering problems encountered and of the steps taken to resolve these problems.

Visual Inspection Problems

It has become necessary to determine the degree of consistency between individuals in their visual analysis of soldered joints. If the specifications are clearly written and easily understood, a high degree of agreement should be attained if the personnel involved are properly trained.

Tests conducted on a random basis show that soldered-joint inspectors attain a coefficient of agreement of approximately 0.64 on a scale of 1.00 as perfect agreement. This indicates that sufficient agreement exists such that supplemental sample boards, as an aid, would provide the necessary basis for control of quality. These sample boards, to be adequate, should indicate obvious defects, marginal joints, and acceptable quality. When used as a guide, the boards will materially increase the efficiency of the inspectors.

Determination of a Good Solderer

Once a system of determining the quality of a soldered joint has been established, it becomes necessary to see if production processes are adequate to produce this quality. Since the process involves a high degree of workmanship, the measurement of the solderer's ability becomes important.

Using jigs that represent typical problems of accessability, solderers should produce typical joints in equal numbers and equal time. These joints should be subjected to rigid testing visually, by x-ray, millivolt-drop tests, tensile-pull tests, and vibration tests. Ranking of the solderers, based upon the results of these tests, will indicate the necessary training or personnel changes required.

The Soldering Process

A third major problem encountered was the actual procedures necessary to the production of a good solder joint. Although the difficulties met in the field of missiles aren't new, they do become more critical and the refinement of procedures must be more exacting. To be specific:

1. Wicking difficulties have been cured by metering the amount of solder used. Further, the use of foot-pedal heat control and resistance soldering iron, leaving the operators hands free, has been of aid in solving this problem.
2. Cold solder joints have been eliminated through the use of the resistance iron and the foot-pedal heat control.
3. The problem of solder-pot voids has been largely eliminated by prefilling the connector pots immediately after cleaning.
4. Cleanliness, a prime factor in good joints, must be controlled in the chemical processing of the flux and in the cleaning of the soldering irons. Here again, prefilling of the connectors eliminates much of the corrosion that accompanies long storage periods.
5. Wire preparation troubles were surmounted by using thermal stripping methods exclusively and by cleaning the wires with an erasure-type cleaner just prior to soldering.

To maintain control over the soldering process, a process control checklist, with a random sampling check procedure, is recommended. This should be supplemented with quality and progress charts based upon the various characteristics of an acceptable soldered joint.

SERVING on the panel which developed the information in this article were:

panel chairman: **I. Dagan,** Rohr Aircraft Corp.
panel co-chairman: **R. H. Gilliland,** General Dynamics Corp.
panel secretary: **C. O. Stump,** Rohr Aircraft Corp.
panel members: **E. C. Bennett,** Northrop Aircraft, Inc.
H. C. Birge, Boeing Airplane Co.
C. M. Geist, Lockheed Aircraft Corp.
H. E. Harris, North American Aviation, Inc.
J. A. Runner, Douglas Aircraft Co., Inc.

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SAE ANNUAL MEETING

continued from page 25

major engineering concern to SAE's more than 23,000 members.

At no previous single meeting has the subject of bearings been attacked quite so broadly or so deeply. Increasing jet engine requirements are behind most of the current attempts to get better high temperature performance . . . and much useful information was exchanged in Detroit. Results of recent researches on high temperature alloys and lubrication were revealed, as were new methods of evaluating tolerable misalignments and various other aspects of the current bearing problem.

New light was also cast on other areas of deep engineering concern such as piston seals for automatic transmissions, air suspensions for passenger cars, European small car design, exhaust gas pollution, manufacture of titanium jet engine parts at lower cost, and solid state physics.

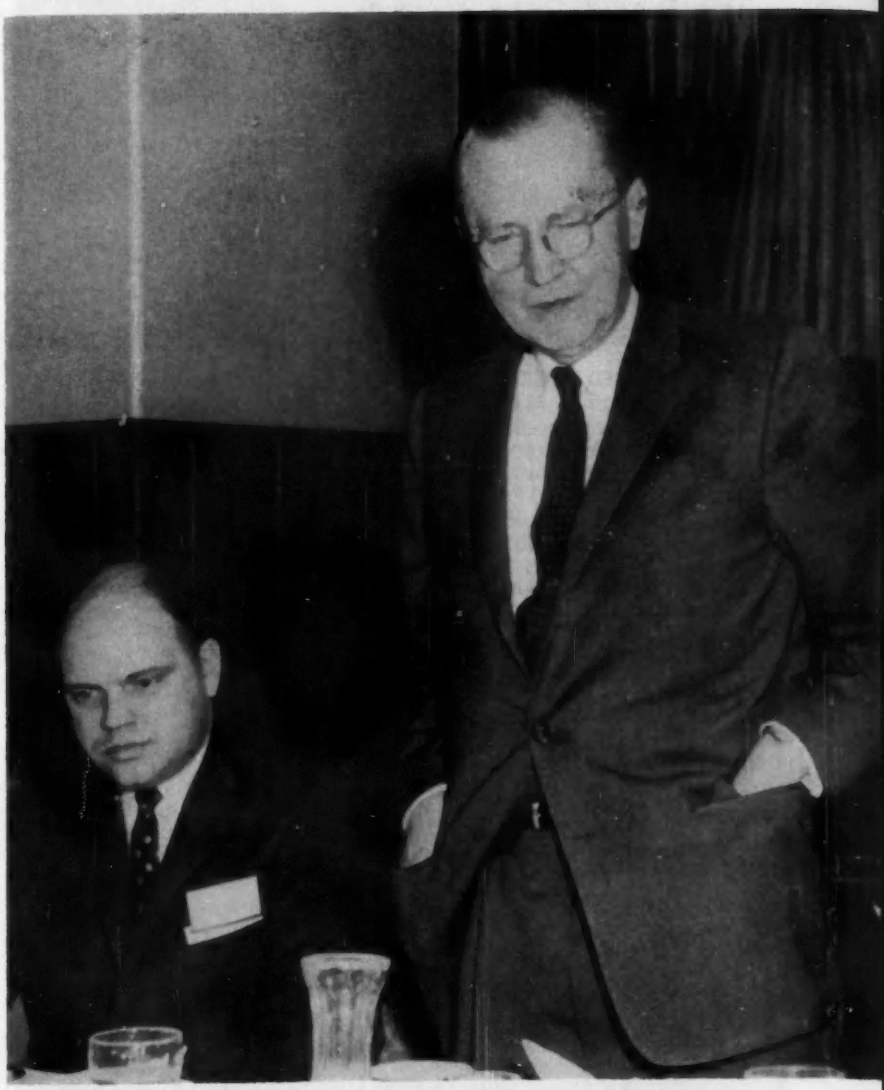
Altogether, there were more than 65 papers presented at the 26 technical sessions, while the usual full quota of technical and administrative committee meetings were fitted in between. Total attendance compared favorably with that of recent years. Some 5,000 members and guests have been making the SAE Annual Meeting a regular event in their business lives for some years now.

New Techniques Revealed

Revealed during the technical sessions were new data on new instruments and techniques that are helping to bridge important gaps in knowledge of how internal-combustion engines work.

Among those which got most attention were:

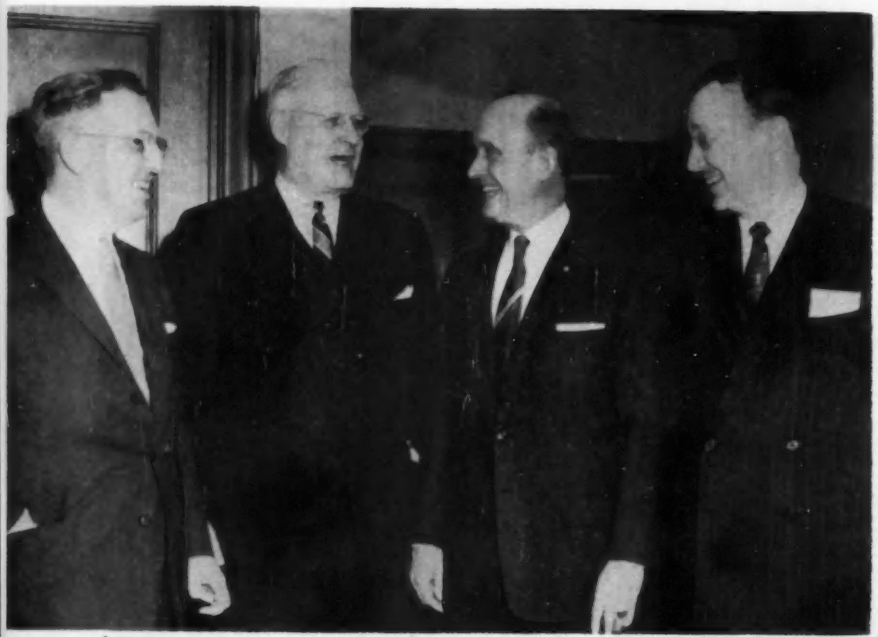
- Velocity-of-sound method to measure instantaneous combustion temperatures.
- Infrared spectrographic and chromatographic techniques for the analysis of exhaust gas.
- Radioactive techniques for the continuous measurement of



1958 SAE PRESIDENT WILLIAM K. CRESON at the Student Committee meeting re-emphasized his view that development of SAE Student activity is a most important aspect of Society progress. (Seated is 1958 Student Committee Chairman Paul F. Allmendinger.)

In his inaugural talk at the Annual Dinner, Creson said:

"SAE is now moving into an era of greatly expanding technology and science. The scope of Society operations is necessarily broadened, human values are more difficult to nourish. But the faith and vision which motivated our founders live on . . . and form a strong arm that will lift SAE to new levels of accomplishment and usefulness."



GEN. ALFRED M. GRUENTHER (second from right), former Supreme Allied commander in Europe and now president, American Red Cross, was the principal speaker at the 1958 Annual Meeting Dinner. More than 1100 members and guests heard General Gruenther discuss some aspects of the United States current security problem. Detroit Section Chairman MILTON J. KITTLER, Holley Carburetor Co., (right) opened the dinner program by welcoming the engineers to Detroit. ROBERT L. BIGGERS, (second from left) president of Chrysler's Fargo Division, introduced General Gruenther. HARRY E. CHESEBROUGH (left) was Dinner Committee Chairman.

W. Paul Eddy, 1957 SAE president, presided at the dinner—and 1958 SAE President William K. Creson outlined plans for his presidential year in a brief inaugural address.

In his dinner talk, General Gruenther indicated that America's somewhat hysterical reaction to the first Sputnik did more actual harm to American prestige in Asia and Europe than did the launching of the satellite itself. The former Supreme Allied Commander in Europe, who was in India the day the first Sputnik went up, reported that the Asian press featured American reaction to the launching even more strongly than they did the scientific achievement the launching represented.

United States can get security in a military sense only through a series of alliances, by which an effective military potential can be developed. NATO defenses, he said, now represent five times the military resources of a few years ago . . . and United States' combination of Strategic Air Force and European-based medium-range missiles provide a superior retaliatory power which the Sputnik launchings have not negated.

He warned, however, that our striking power in the economic and psychological phases of the cold war must be built and implemented to similar effective potentials. In these areas, he said, we have not been willing to spend money for experimental developments . . . which we must promote at least as eagerly as we are now willing to back further military growth. It is in these two areas, he stressed, that we are in more danger of losing the cold war than in the purely military area. He pointed to Russia's billion-dollars-per-year expenditures in economic and psychological attack as part of the cold war, stressing how little United States has spent and used in the same phases.

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piston-ring wear in a moving car.

- Use of the digital computer to simulate a free-piston engine.

Massachusetts Institute of Technology is developing a sound-velocity technique for measuring instantaneous combustion temperatures in spark-ignition engines. This technique was reported to be applicable to the study of the effect of operating variables on end-gas temperatures, during the compression process.

The method involves transmitting an acoustical impulse through a gas path of known length and measuring the time or propagation through the gas. Such a measurement will yield the average velocity of sound in the path. The temperature is then derived from this velocity by means of suitable equations.

Progress reports on some of the methods of exhaust gas analysis being studied by CFR groups were presented. Two of those described were:

- Continuous-reading infrared spectrographic techniques for the quantitative analysis of carbon dioxide, and total hydrocarbons under transient conditions.
- Gas-liquid chromatographic techniques for separating and quantitatively measuring the C_2 through C_6 hydrocarbons in exhaust gas.

The infrared techniques have been used successfully to study the effect of engine variables on exhaust gas composition. They also made possible the large-scale field survey of vehicle exhaust gas conducted in Los Angeles in November, 1956.

The chromatographic technique was developed by the Bureau of Mines in cooperation with CRC. Future plans include extending the method to identification of C_6 and higher molecular weight non-aromatics and C_9 and heavier aromatics.

The results of a radiotracer study to obtain a better understanding of the factors governing

piston-ring wear showed, for example, that:

1. At low jacket temperature, very severe piston-ring wear occurs, due to corrosive action by products of combustion.
2. The magnitude of low-temperature ring wear is influenced by fuel components capable of producing corrosive materials on combustion.
3. Present-day compounded oils are effective in reducing this type of wear, although the results indicated that further improvement is possible.
4. Some rust preventives are effective in reducing low-temperature wear.
5. Zinc dialkyldithiophosphate is not effective in reducing low-temperature ring wear.

These and other conclusions were obtained in a study of a passenger car whose engine was equipped with radioactive top compression rings. Wear was determined by monitoring the crankcase oil for radioactive iron continuously while the car was in operation.

Free-Piston-Engine Analysis

The digital computer was reported to have been a highly useful tool in making a general analysis of the free-piston-engine process that realistically simulated an operating engine. The analysis was made in terms of variables that:

1. Allowed the basic engine size and configuration to be selected.
2. Allowed the operating conditions for the hypothesized engine to be arbitrarily fixed.

For these conditions, a solution from the analysis gave a numerical description of the performance that may be expected of the engine.

Most of the actual calculations were performed on an IBM 704 digital computer.

This analytical simulation appears to be sufficiently realistic so that the merits of major changes in engine design and operating conditions can easily be evaluated.

It is a relatively cheap tool, compared to the construction and testing of operating units. It cannot, however, be looked upon as a substitute for engine development. Many important aspects of processes that occur in the engine and greatly influence the performance still defy analysis. Simulation can be used to gain a better understanding of the many parameters that influence operating units.

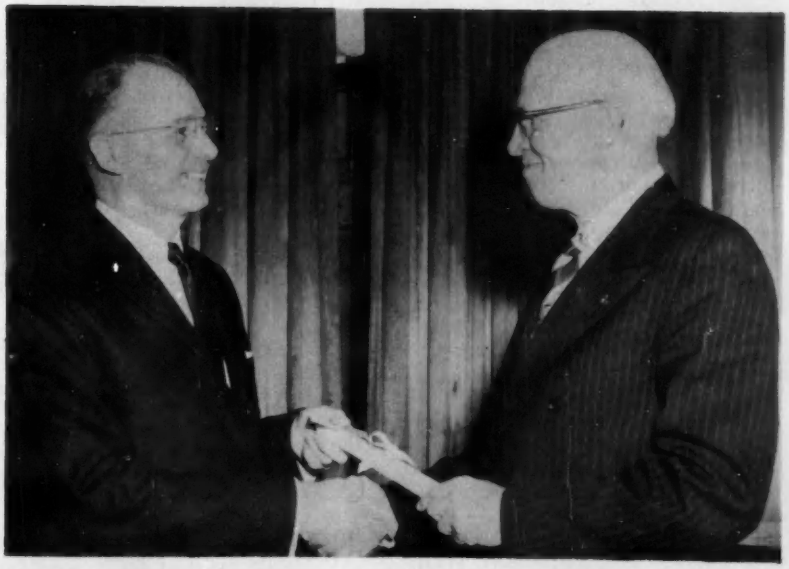
Aeronautical engineering has reached a stage where it costs so much to develop an airplane that there can be few competitive manufacturers of a given type of airplane, either military or commercial.

Then too, each manufacturer exploits to an increasing degree each advance in the art of aircraft design. Therefore, the few

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1957 SAE President W. Paul Eddy (left) and 1958 SAE President William K. Creson (right) exchanged views prior to the Annual Meeting Dinner at which both spoke briefly. Eddy emphasized the specific advances made in 1957; Creson stressed that "the Society is strong and well equipped for the execution of the thoughtfully-made plans being developed for its future growth."



A LIFE MEMBERSHIP was presented by 1957 SAE President W. Paul Eddy (left) to SAE Past-President C. G. A. Rosen (right). The occasion was Rosen's completion of his 2-year term as a Past President on SAE Council. Presentation was made at the Annual Business Session, Tuesday evening, January 14.

Past-Presidents at 1958 Annual



C. E. Frudden (1947) C. G. A. Rosen (1955) G. A. Delaney (1956) J. G. Vincent (1920)

SAE Past-Presidents Continue to Serve Society

SEVENTEEN of SAE's living Past-Presidents were in attendance at the 1958 Annual Meeting. Most of this 70% participated in the traditional Past-Presidents' Dinner on Jan. 14. . . . But all 24, regardless of this particular meeting, continue the tradition of never-flagging interest in SAE . . . and, in many cases, of continued active service to the Society's membership.

Examples of this continued service by Past-Presidents are numerous as 1958 begins. For instance:

B. B. Bachman, 1922 President, for example, begins in 1958 another term as treasurer, a post to which the Society has elected him every year since 1944 . . . and he continues as a member of the Finance Committee, the Planning for Progress Committee, and as chairman of the Recognitions and Awards Committee.

1940 President Dr. Arthur Nutt —a member of the first SAE Technical Board—begins in 1958 a new 3-year term on this important Board. Also he continues as a member of the Board's Aeronautical Committee and as chairman of the Aeronautic Committee's Special Projects Subcommittee. . . . 1941 President A. T. Colwell continues to lead the SAE Finance Committee. . . . 1944 President W. S. James is chairman of Subcommittee B of the SAE Fuels and Lubricants Technical Committee and a member of the F&LTC itself. He is also an active member of the Passenger Car Activity Committee.

. . . . 1945 Past President James M. Crawford last year set up the James M. Crawford Fund "to see the cooperative method of getting things done preserved—and matured to even higher levels of development in SAE."

. . . . 1948 President R. J. S. Pigott is chairman of the Planning for Progress Committee whose current work is laying the foundations for a more flexible and stable Society structure in which members will be able to participate more fully.

. . . . 1952 President D. P. Barnard is a member of the Overseas Information Committee . . . 1954 President William Littlewood, of the Publication Committee.

. . . . 1955 President C. G. A. Rosen continues as a member of the Overseas Information Committee, having been its first chairman; is still an active member of the Diesel Engine Activity Committee; and has just finished his second year on SAE Council as a Past-President.

. . . . 1956 President George A. Delaney, who inaugurated the Planning for Progress program when he was president, has been a moving force in development and integration of that program as a working member of the Planning for Progress Committee. He is also serving SAE actively in a number of other posts including: member, Finance Committee, chairman Committee on Interpretation of the Society's Constitutional Areas of Operation, and, as a Past President, member of SAE Council through 1958.

. . . . 1957 President W. Paul Eddy, in addition to beginning his two-year term on SAE Council as a past-president, has accepted appointment to membership on the new Science-Engineering Committee, which, as president, he was instrumental in inaugurating.

Meeting



R. R. Teetor (1936) R. J. S. Pigott (1948) Arthur Nutt (1940)



C. F. Kettering (1918)

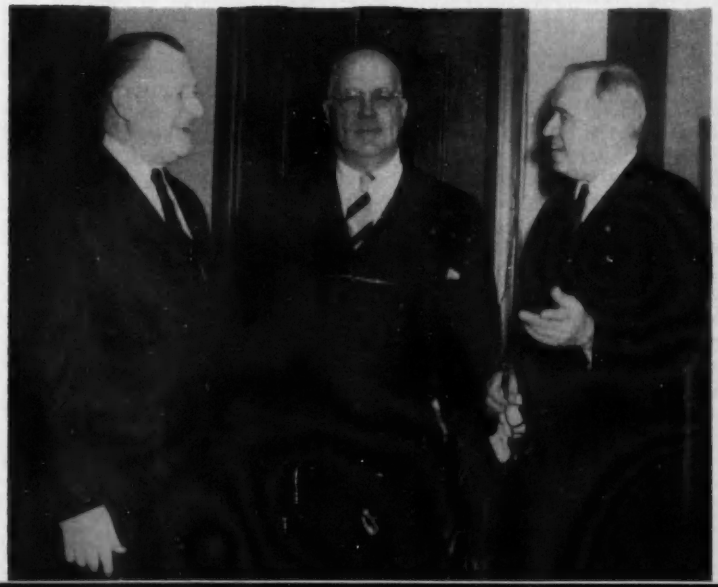


W. S. James (1944)



J. H. Hunt (1927) Robert Cass (1953)

William Littlewood (1954) J. C. Zeder (1950) D. G. Roos (1934)



D. P. Barnard (1952) Dale Roeder (1951)





THE CONSTITUTION COMMITTEE has already been advising with the Planning for Progress Committee; soon will be responsible for developing Constitution and By-Law provisions and modifications to implement PFP program. Results of Constitution Committee's work will comprise the form in which PFP program will go to members for final vote. At the January 13 meeting of this 3-member Committee were (left to right): O. A. Brouer; 1957 Chairman R. R. Faller; 1958 Chairman C. C. Dybvig, and G. A. Delaney.

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competitive airplanes for a given mission or type of service become more nearly uniform in all their physical features and performance.

This trend toward equipment uniformity may be a boon to the military—as long as the few designs available to them are the very best possible at the time.

It may save money for operators of commercial aircraft too, as standardization traditionally does. And no doubt some of the new equipment—like turbine helicopters capable of carrying 20-25 passengers 125 miles prophesied for 1960—will fill long-felt needs. But uniformity will make it increasingly difficult for any one operator to get and hold a competitive advantage in flight equipment.

As military and commercial requirements diverge and commercial models are being forced to bear costs of their own prototype development, equipment advantage—historically an important reason for the success of one airline over another—is vanishing. Only the temporary advantage of an early delivery position remains. As a result, airlines engineers realize that the opportunity for competitive advantage now lies not so much in flight equipment but in facilities and procedures for passenger loading and airplane service at the terminal concourse. Any airline can fly the passenger speedily and comfortably from point to point. The airline that will have the advantage in getting his business is the one that gives him the best service from the time the sale is made until he takes his seat in the plane, particularly at the terminal.

These were the acknowledged reasons behind the interest airlines engineers at the Meeting showed in devices for loading passengers and servicing the airplane while it's at the terminal concourse. They were especially interested in American Airlines' plan for handling jet transports: Taxi the airplane straight in, extend a two-level "bridge" to the forward and rear passenger doors, load passengers via the upper level, service the plane from the lower level, push the plane out and turn it with a tractor, unhook the tractor, and taxi the plane to the runway.

They were interested, too, in devices for insuring smooth, speedy braking after touchdown. Panagra has been testing a skid warning system that taps the pilot's foot through the brake pedal to warn him when his wheels are skidding that he should release his brakes, it was reported. Results show that the pilot can react fast enough to prevent flat-spotting of tires even under the most adverse runway conditions. Stopping distances were said to be materially reduced.

Even faster brake release was



OVERSEAS PRODUCTION ENGINEERING was the subject of a full session developed by the Production Activity. It was typical of a widespread upswing in interest in overseas engineering developments reflected in many SAE areas since establishment of SAE Overseas Information Committee more than a year ago. Here are G. R. Fitzgerald (left) AC Spark Plug, who chairmanned the session for the Production Activity; Harold Johnson, Vauxhall, who spoke at the session.



SAE'S NEW SCIENCE ENGINEERING ADVISORY COMMITTEE held its first meeting in Detroit on January 16. Plans were made to speed and direct transition between scientific discovery and engineering application . . . giving scientists an outlet for practical realization of their work, and engineers an opportunity to express their needs for the fundamentals on which their work feeds.

Areas discussed included: industrial research's role and function, exotic fuels and free radicals, human engineering, theory of traffic dynamics, solid state physics and electronic applications, current state of Russia's engineering and science knowledge, and mathematical techniques and analytical approaches to automotive engineering problems.

The Committee will work through the existing SAE facilities and committees in these and other areas to bring to engineers the newer scientific techniques and research methods.

"The delay between the scientific discovery on which invention is based, and the invention, has become progressively shorter," says Dr. L. R. Hafstad . . . "and now has essentially disappeared. This represents a qualitative change in the relationship between science and engineering."

Members of the committee shown in the picture are: (l. to r., seated) Dr. J. A. Bolt, University of Michigan and Dr. L. R. Hafstad, General Motors; (l. to r., standing) Dr. Michael Ference, Ford; T. B. Walker, Aerojet-General; Dr. T. F. Nagey, Martin; Dr. John Versace, Chrysler; and Dr. W. H. Goss, Johns Hopkins. At the first 1958 Council meeting 1957 President W. Paul Eddy's appointment to the committee was approved.

claimed for an anti-skid system that acts on the brake automatically without requiring any response from the pilot.

Meanwhile, in the effort to exploit every engineering advance, bearings came in for particular attention. There were a session on engine bearings and an all-day symposium on tiny bearings for aircraft electric motors. Turbine engineers welcomed the news that preliminary tests indicate antifriction bearings made of vacuum-melted M1 steel show far better fatigue life than those from conventional melts.

For electric motors, bearing refinements are constantly being pushed on the design, materials, and lubricants fronts. Members heard much, for example, of high-temperature operation of missiles and aircraft accessory motors that demand new manufacturing tolerances, steels, and perhaps solid lubricants.

To meet high performance requirements, secondary loadings must be reduced or eliminated, the industry was told. Some offenders mentioned were:

- Misalignment and tolerance buildup of output gears.
- Uneven thermal expansion, dynamic unbalance, ball skidding, and eccentric magnetic forces on armatures.
- Non-uniform thermal expansion and misalignment of housing bores of stators.
- Fretting corrosion and grease



CERTIFICATES OF APPRECIATION were presented to 30 members of technical committees by Technical Board chairman A. E. W. Johnson (shown opening the ceremony) at a luncheon following the Board meeting. The 3000 technical committee members had nominated these co-workers for their outstanding contributions to technical committee projects. Story about the certificate recipients begins on p. 96.)

SAE ANNUAL MEETING

breakdown due to external vibration.

• Gyroscopic couples and linear acceleration resulting from external forces.

Increasing the bearing radial looseness is one solution to high-temperature differentials, reported the panel. Stepping down the tolerances on bearing OD and housing bore to help misalignment and stall bearing creep was another solution offered.

Special tests are being developed to check improvements of design, materials, and lubricants. Outer race misalignment and radial play will be the two independent variables in a new high rpm test. Ball rig tests have already outstripped bending fatigue tests for ball-bearing material evaluation.

Temperatures as low as – 100 F and as high as 1000 F will push bearing lubrication out of the conventional grease range. New thickeners used with silicone oils have extended the present 400 F limit another 100 deg or more. It remains for solid lubricants to satisfy the high-temperature limits. Oxide-supported or moist graphite was held up at the meeting as an example of successful 1000 F operation.

Among the interesting things revealed by materials and production engineers were these:

• A new extrusion-fabrication technique for making ring-shaped titanium jet engine parts.

• The development to usable form of two new test procedures aimed to overcome the objections of the salt spray method of testing plated coatings.

• Plated steel parts perform better from a corrosion standpoint than do plated zinc-base die-cast parts.

• A dull nickel undercoat provides longest life for chromium plate.

• The lip-type seal provides many advantages in automatic transmissions.

Curtiss-Wright has developed a process of making ring-shaped titanium jet engine parts by extruding a suitable cross-section in strip form, cutting the strip, bending into a circle, and welding together the ends. Cost savings provided by the new process run from 25 to 45%.

Raw material savings provide a large portion of the cost savings. These material savings amount to as much as 50% when compared with conventional methods of manufacture. This can be attributed to the smaller machining envelope needed by the process.

An additional increment of cost savings is provided by extruding the cross-sections directly from cast ingots rather than from forged billets. This procedure eliminates the cost of the forging operation as well as the material lost in the forging operation.

The extrusions are formed on a 12,000-ton horizontal extrusion press capable of processing stock from 8 to 24 in. in diameter

Standardization and calibration of two new tests for plated coatings are still to be completed by the Research Project of the American Electroplaters Society. The AES group has already developed to usable form, however, these two test procedures:

• A new acetic acid modification of the salt spray test (ASTM B117-54T).

• A "Corrodkote" test.

Both of these tests are aimed to overcome valid objections to the long used salt spray test.

Data made available most recently from the AES group's progress toward standardization and calibration include specifications for the equipment and method of conducting the new acetic modification of the salt spray test.

On exterior automotive applications, plated steel parts perform better from a corrosion standpoint than do plated zinc-base die-cast parts.

The survey stresses the need for a new specification for the plating of zinc-base die castings—although what the specification should be is not yet established.

Recent observation with respect to the durability of decorative plating show that:

- "Double layer" buffed dull nickel chromium coatings provide much better protective value in marine and rural atmospheres than do single layer nickel-chromium coatings of the same total thickness.
- The protective value of bright nickel coatings under bright chromium is generally inferior to buffed dull nickel of the same thickness when exposed to the weather.
- Increasing the thickness of bright nickel under chromium improves the protective value of the composite.
- Chromium plating bright nickel may have an adverse effect on its protective value. However, increasing the thickness of the chromium from three to six times that normally applied has a marked beneficial effect.

The lip-type seal finds extensive use in automatic transmissions as clutch and servo piston seals.

The flexible lip of the seal allows easy assembly of the piston and seal into the bore. This same deflection sealing characteristic provides a near-optimum friction condition.

Wear of the seal is negligible because the deflection action of the lip in the assembly is such that, while oil is effectively prevented from passing, the peripheral force is inherently below that critical point which would excessively stress rubber in tension, causing wear.

Bore out-of-round conditions are compensated for by lip seal as the lip will easily follow the anomalies of the bore contour and, in addition, tolerate considerable misalignment. Similarly, thermal changes of the piston and bore are easily accommodated by the flexible lip.

A variety of passenger-car and truck information came to light at the Meeting. Particularly pertinent, as 1958 begins, are the data on air-suspension systems, small cars, styling, noise reduction, truck driver comfort and safety, and European cars.

Oldsmobile, it was noted, is using a closed air-suspension system with a maximum allowable leak rate of 4 cu in. of free air per hr for any component of the system. Leak rate allowable at any pipe connection is set at 2 cu in. of free air per hr. Theoretically, this means that an Oldsmobile equipped with air suspension will sustain itself for over three weeks without compressor assist.

Oldsmobile (the only manufacturer to use a closed air-suspension system) has taken another interesting precaution in designing its air-suspension system. Both the high-pressure and the low-pressure tanks are coated with a special zinc chromate paint. Air-spring pistons and lower diaphragm retainer rings are cadmium plated. Thus, all internal parts of functional units, such as separator and height valves, are either made of noncorrosive materials or are plated.

Ford engineers have designed a so-called "open" type suspension in which air is taken from the atmosphere and, after use, is exhausted to the atmosphere. This system was chosen, Ford engineers told their confreres at the meeting, because "it eliminates the complications of a low-pressure tank and its attendant air lines."

Extensive tests, they say, showed the importance of maintaining air pressure as it enters the spring at 150–160 psi. A pressure regulator performs this function. It was found that, if the system were operated at 300-psi reservoir pressure with the rear-spring pressure at 80 psi, there would be a 220-psi differential. On a long stretch of rough road, especially washboard, far more air would be admitted during jounce



MEETINGS COMMITTEE CHAIRMAN A. O. WILLEY (right) has been selected a Councilor to serve for the year 1958. He is vice-president in charge of engineering, Lubrizol Corp. The 1958 Council chose Willey to complete the two-year term of William K. Creson, who resigned to become SAE President for 1958.

Here, Willey is leading a well-attended session of his 1958 Meetings Committee in a discussion of 1958 plans and policies.

Vice-Chairman Harry E. Chesebrough, who is also a member of the SAE Planning for Progress Committee, outlined for the Meetings Committee PFP proposals for revisions in Society structure. Background for his discussion was the article, "Planning for Progress," which appeared in the January SAE Journal.



PLACEMENT COMMITTEE members approved the work now nearing completion in development of a list of SAE members available to do full or part time consulting work. One hundred names are expected to comprise the first list scheduled for issuance early in February. (Proposed method of handling this new service was outlined in SAE Journal, October, 1957, p. 102.) (Left to right): Paul L. Dumas, 1957 Chairman Lowell O. Ray, 1958 Chairman Arthur R. Hempe, Jr., John H. Dittfach, and Thomas M. Dunn. (V. L. Westberg is also a member of the 1958 Placement Committee.)

SAE ANNUAL MEETING

operations than could be exhausted during rebound motions. A pressure of 150–160 psi provides desirable balance, tests showed.

Many of the details of the new Rambler suspension system were disclosed for the first time. Rambler uses air springs at the rear wheels only. Advantages claimed by Rambler engineers for their air suspension are: (1) reduction in the number of parts, (2) maximum interchangeability with standard coil spring suspension, (3) greater ease of manufacture and improved serviceability, (4) lower cost. Since most of the load is on the coil springs, Ramblers can be shipped without any air in the system.

Air-suspension systems of Buick and Chevrolet were also described.

Small cars were avidly discussed at the Meeting. Surveys made by *Fortune* showed remarkable customer satisfaction on the part of owners of small foreign cars. One of these surveys revealed that 99% of the small car owners would buy a small car again. Another interesting *Fortune* discovery: a substantial number of small foreign car owners have no other car.

The fact that 85% of the mileage of today's cars consists of short runs has no doubt aided the popularity of the small car. And, the increase in the number of "two-car" families probably has been an important factor in raising small car sales. In 1948, only 6.66% of our car owners had more than one car. The latest registration figures show that at the close of 1956 this country had 24.29% multiple car owning families.

Moving the transmission to the rear of the car won't solve all of the industry's engineering problems, a GM stylist revealed. Transmissions will still require considerable space. And this space will come out of the trunk space. Add lower rear decks and you limit both space and useful geometry. Perhaps even more important, he revealed, this configuration severely limits the station wagon where the clearance between ceiling and floor becomes too shallow.



TOMORROW'S PRODUCTION potentials were envisioned in terms of engineering and research progress by Ford Vice-President A. A. Kucher (left) at a luncheon sponsored by the SAE Production Activity on January 14. Toastmaster at the luncheon was Thompson Products' C. W. Ohly (right) who is vice-chairman for membership of the 1958 Production Activity Committee.

When investigating vehicle noise problems, engineers at the Meeting were told, it is almost always unwise to replace human reactions entirely with electronic instruments. Electronics should be used, they were told, to extend and supplement human facilities.

The truck driver's comfort—as well as his safety—were vigorously discussed. From the standpoint of styling, driver comfort, and safety—as well as from an engineering standpoint—today's motor trucks get almost as much attention as passenger cars, it was revealed. A very intensive study of driver safety and comfort was presented.

Foreign cars were also discussed. The Citroen DS-19 was covered in detail. As early as 1934, Citroen was using front wheel drive, unit frame and body, and torsion bar suspension all around. Among a number of interesting features of the DS-19 are a central hydraulic system consisting of a single high-pressure pump and accumulator. While all details are not available, a sealed high-pressure pump, replaceable as a unit, is used. The pump is a 7-cyl, wobble-plate type, capable of a peak pressure of 2400 psi. The unit is driven by a single V-belt at camshaft speed. The high-pressure system supplies braking, steering, suspension, and clutch control.

SAE Engineering Display

THE SHERATON-CADILLAC HOTEL

January 13-17, 1958

EXHIBITOR LIST

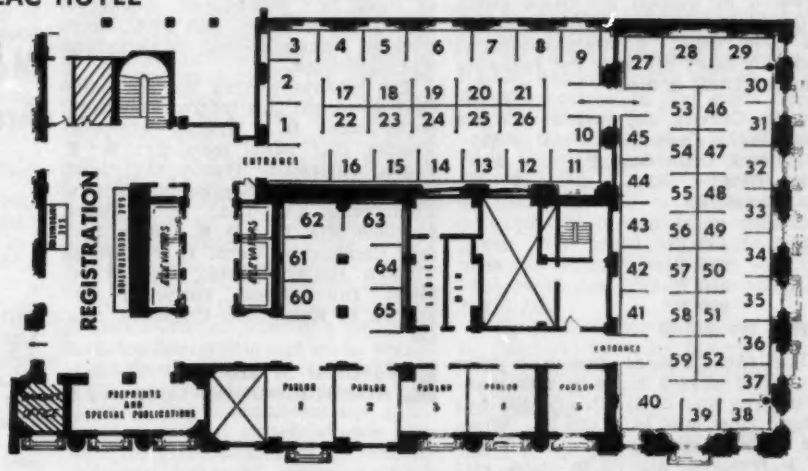
Parlor

1. Zollner Corp.
2. The Cleveland Graphite Bronze Co.
3. Aluminum Co. of America
4. Ross Gear & Tool Co., Inc.
5. Vickers, Inc.

Booth

1. American Bosch Arma Corp., American Bosch Div.
2. Cities Service Petroleum, Inc.
3.-4. Continental Motors Corp.
5. Dualoc Drive, Inc.
6. Fram Corp.
7. The Satullo Co.
8. Lord Mfg. Co.
9. Borg-Warner Corp., Long Mfg. Div.
10.-11. Kelsey-Hayes Co.
12. Lipe-Rollway Corp.
13. Detroit Aluminum & Brass Corp.
14. Fairchild Engine & Airplane Corp., Al-Fin Div.
15. LaSalle Steel Co.
16. Hoof Products Co.
17. Jervis B. Webb Co.
18.-19. Aeroquip Corp.
20. Magnaflux Corp.
21. Borg-Warner Corp., Warner Automotive Parts Div.
22. Monroe Auto Equipment Co.
23. The Torrington Mfg. Co.
24. The Pierce Governor Co., Inc.
25. Lincoln Engineering Co.
26. Schwitzer Corp.
27. Johnson Bronze Co.
28. Rosan, Inc.
29. Metal Finishing Service
30. Kistler Instrument Corp.
31. General Radiator, Inc.
32. Avon Tube Div., Higbie Mfg. Co.
33. Enjay Co., Inc.
34. Reynolds Metals Co.
35. Anchor Coupling Co., Inc.
36. Heli-Coil Corp.
37.-40. Bendix Aviation Corp.
41. Waukesha Motor Co.
42. Eagle-Picher Co., Fabricon Products Div.
43. The Leece-Neville Co.
44. MB Mfg. Co.
45. Detroit Controls Div., American-Radiator & Standard Sanitary Corp.

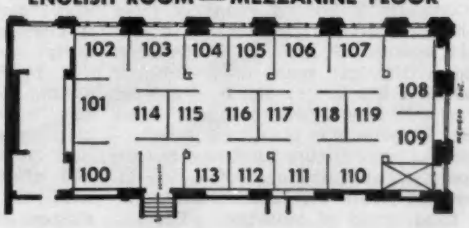
FOURTH FLOOR



46-47. Organic Chemicals Dept., Elastomers Div., E. I. du Pont de Nemours & Co., Inc.
48.-49. Polychemicals Dept., Plastics Div., E. I. du Pont de Nemours & Co., Inc.
50. Wyman-Gordon Co.
51. Stratoflex, Inc.
52. Bohn Aluminum & Brass Corp.
53. Lisle Corp.
54. J. R. Dannemiller Associates
55. Grob, Inc.
56. Huck Mfg. Co.
57. The Dow Chemical Co.
58. Flexonics Corp.
59. The Garrett Corp., AiResearch Industrial Div.
60. Dana Corp.
61. Deluxe Products Corp.
62. Armstrong Cork Co.
63. Kaiser Aluminum & Chemical Corp.
64.-65. Hercules Motors Corp.

100. Thompson Products, Inc.
101. Sun Oil Co.
102. General Dynamics Corp., Liquid Carbonic Div.
103. Perfect Circle Corp.
104. The Kaydon Engineering Corp.
105. Chelsea Products, Inc.
106. Ampex Corp.
107. Fawick Corp., Fawick Brake Div.
108. American M.A.N. Corp.
109. Associated Spring Corp.
110. Lapeer Mfg. Co.
111. Committee of Stainless Steel Producers, American Iron and Steel Institute
112. International Nickel Co.
113. The Beryllium Corp.
114. Heyer Industries, Inc.
115. Hoover Ball & Bearing Co.
116. Lake Shore, Inc.
117. Battelle Memorial Institute
118. Armco Steel Corp.
119. Spray Products Corp.

ENGLISH ROOM — MEZZANINE FLOOR



Hot Oil Quenching Boon to Gear Makers

Based on secretary's report by

W. E. FRANK
Caterpillar Tractor Co.

SUCCESSFUL results with hot oil quenching are reported by two companies which are using it extensively. Company A obtains quench uniformity with a temperature of 400 F; Company B uses a temperature of 300 F. Both control temperature to ±5 F and both have found filtering to be impractical and uneconomical.

Company A uses five continuous type furnaces to quench all truck gears, spline shafts, and pinion shafts except the bevel gear. A straight mineral (paraffin base) oil with the following characteristics is used:

Specific Gravity, deg API	28.3
Flash Point, Open Cup, F	515
Fire Point, Open Cup, F	590
Color, NPA	5
Pour point, F	5
Viscosity:	
SUS at 100 F	1152
130 F	463
210 F	96
400 F	36
Cost, ¢ per gal	33 to 37

The five furnaces quench a total gross load of 3200 lb per hr with maximum tray load of 250 lb. Oil life has ranged from 6000 to 14,000 hr. When the viscosity reaches 600 at 210 F the oil is removed, filtered to clean, and blended with a good grade of motor oil to make a good SAE 90 transmission grease. The maximum section quenched is 2½ in. in diameter, requiring a 6-min quenching time.

Hot oil quenching requires re-establishing machine dimensions. Both companies find gears and shafts can be held within a ±0.002-in. tolerance, and drag out is lower than with conventional quenching oil.

Custom calls for blanketing hot quenching oil compartments with exhaust gas or a DX-type atmosphere to prevent the accumulation of the gases and atmosphere which may leak from the furnace and create an explosion hazard when mixed with air. The blanketing atmosphere is not thought to prolong the life of the hot quenching oil if circulation is used only during the quench cycle.

Company B hot oil quenches from a Super All-Case furnace. A maximum charge of 1200 lb is quenched into a 1600-gal tank, using Sinclair Quenchol No. 524 at 300 F, protected by a DX atmosphere blanket. Most gear sections are quenched satisfactorily to desired core hardness, but an experimental quenching of a 2⅜-in. diameter shaft was unsuccessful, due to fixed speed of agitation. The attainment of surface hardness is no problem. The effective case is more easily quenched out with hot oil than conventional oil and with greater uniformity. It has been observed that, for a heavier section at a given hardenability band level where conventional treatment resulted in a core hardness up to 30 Rc, hot oil consistently and uniformly produced 28 Rc.

When parts are selected with discretion, rerouting to hot oil quenching facilities, plug quenching and die quenching can be eliminated. For example, a splined spiral bevel pinion shaft distorted badly in conventional oil quenching and was difficult to straighten because of its full length hardness. This shaft in a 36-piece pilot lot indicated a maximum runout of 0.002 in. Subsequent production runs totaling more than 2000 pieces were so successful that straightening was eliminated.

The experts serving on the panel that developed this information were: panel leader: **D. J. Wright**, Caterpillar Tractor Co.; panel secretary: **W. E. Frank**, Caterpillar Tractor Co.; panel members: **R. S. Segsworth**, General Engineering Co., Ltd.; **H. J. Bates**, Fairfield Mfg. Co.; **O. E. Cullen**, Surface Combustion Corp; **D. J. Girardi**, Timken Roller Bearing Co.; **W. C. Hiatt**, International Harvester Co.; and **R. F. Kern**, Allis-Chalmers, Mfg. Co.

To Order SP-320 . . .
on which this article is based, see p. 5.

Q-C Engineer Links Design and Production

Based on secretary's report by

C. O. STUMP
Rohr Aircraft Corp.

THE quality control engineer provides an effective liaison between design engineering, quality control, and production. His most effective contributions to the production airplane are to:

1. Analyze at the design stage to determine acceptance criteria compatible with the design intent.
2. Assist in specifying requirements based on available process capabilities and recommend specification changes in cases of inadequacy or impracticability.
3. Provide technical assistance to quality control in interpreting the design intent and in the development of acceptance procedures.
4. Develop reporting systems that will effectively provide the designer with the information required for changes or future designs.
5. Develop measurement systems that will accurately determine product conformance to specifications and coordinate these systems with production, inspection, and vendors.

Other members serving on the panel which developed the information in this article were: **I. Dagan**, Rohr Aircraft Corp.; **R. H. Gilliland**, General Dynamics Corp.; **E. C. Bennett**, Northrop Aircraft, Inc.; **H. C. Birge**, Boeing Airplane Co.; **C. M. Geist**, Lockheed Aircraft Corp.; **H. E. Harris**, North American Aviation, Inc.; and **J. A. Runner**, Douglas Aircraft Co., Inc.

To Order SP-321 . . .
on which this article is based, see p. 5.

More Plastics Are Coming for Cars

Based on talk by

RAYMOND F. BOYER
Dow Chemical Co.
(As reported by W. H. Lichty, SAE Mid-Michigan Section Field Editor)

THE use of plastics in automobiles, now averaging 19 lb per car, will double by 1960.

Among the new plastic materials are: Tyril, a styrene copolymer; Lexan, a polycarbonate developed by General Electric; a polyurethene foam, and a new polyethylene foam. Tyril offers advantages of easier molding, higher strength, and better gasoline resistance than styrene now being used, although its weathering properties are not yet as good.

Lexan is cheaper than nylon, yet has better abrasion, oxidation, and temperature resistance and higher impact strength. It demonstrates good transparency, suggesting that some day a clear plastic will be developed to replace windshields and windows.

The polyurethane foams offer a wider range of properties than foam rubber at a substantial reduction in cost. He cited 28¢/board-ft for this plastic as compared to 42¢ for foam rubber. The polyethylene foams are stiffer (less resilient), cheaper, and more resistant to oxidation than either the polyurethene or foam rubber.

There are many more new plastic materials coming along, these are but typical examples.

New plastic techniques include new developments in water-base paints and uses of atomic radiation. The use of water-base paint as a metal primer is of great interest to the automobile industry because of its safety aspects. It is already being used by one company, and extensive use by others can be expected soon. The primer is an organic plastic suspended in water with

pigments added for color. Water has the obvious advantage of being cheap, nonflammable, and nontoxic as compared with present solvents used in paints.

One of the possible commercial uses of radiation is in reducing the curing time of plastics. A gain of 10–30 fold in cure time is possible, which could make fiberglass a much more attractive material for replacing metal.

Vulcanizing—or cross-linking—polyethylene plastics is another act which radiation can perform. This transforms a thermoplastic material into a thermoset (permanent shape) material. Ten cents worth of radiation will treat one pound of polyethylene rubber at room temperature in seconds. With such techniques, wire can be coated at half the price of teflon with many of the same properties, including good heat and solvent resistance.

Grafting of a soft flexible material to a hard material (for example, polyethylene to polystyrene) is another trick which can be performed by radiation. Both cross-linking and grafting can be explained by comparing the materials, after exposure, to a bridge game. Three hydrogen atoms, gathered around a carbon atom have lost their "fourth for bridge" as a result of electron bombardment. In search of a fourth, two such tables join together and the operation is completed. This is neither good bridge nor good chemistry, but gives a rough idea of what happens.

Good Inventory Control Based on Sales Forecasts

Based on secretary's report by

T. H. GREDE
Keystone Pipe and Supply Co.

THE main factors involved in effective inventory control are an accurate sales forecast and its proper conversion into planned production.

A sales forecast, no matter how good it is originally, is accurate only if regularly adjusted to actual sales and changing market conditions.

Planned production can be achieved only through an accurate computation of lead times—without pyramiding or overlapping necessary lead times on raw material, parts, subassemblies, and finished products.

Others serving on the panel which developed the information in this article were: **P. A. Scheuble, Jr.**, Vapor Heating Co.; **J. S. Ross**, A. O. Smith Corp.; **Bert Lynn**, General Motors Corp.; **B. A. Cummings**, Thompson Products, Inc.; **W. J. Jones**, Chrysler Corp.; and **T. S. Wilmeth**, Scott Industries.

To Order SP No. 320 . . . on which this article is based, see p. 5

Watt-Muscles In the Modern Automobile

Based on talk by

JOSEPH C. JOHNSON
American Bosch Division,
American Bosch Arma Corp.

(As reported by R. S. Karlson SAE Southern New England Section Field Editor)

ALTHOUGH the average person spends a good deal of his time talking, he actually spends a very small part of this time talking or even thinking of muscles. Our present-day way of life depends very much on our muscles and their proper responses. This is true of both our personal muscles as well as the various "muscles" in the sleek new automobiles that we drive. We expect all these muscles to work upon demand and yet the only time we actually think about them is when they fail to work properly. These various muscles, human and mechanical, must be fed, as we well know. In the case of the present-day automobile it may be surprising to learn the amount of "food" that the many "watt-muscles" require.

For example, the electrical demands of the various "muscles" of a 1957 Ford hard-top convertible add up to a total of 35 amp of continuous-duty (ignition, lights, windshield wipers, heater, and so on). The intermittent-use items (such as the seat mover, window lifts, horn, top and trunk operating mechanism) total 500 amp. Assuming a 2.5% use factor, this would be equivalent to approximately 15-amp continuous load. The maximum equivalent continuous power consumed is then seen to be between 600 and 700 watts.

With the figure of somewhat less than 700 watts in mind, it is interesting to go back in history and trace the development of automotive electrical demand in the motor car from the days of the first "gas buggies." Fig. 1 shows the changes in electrical demand through the years.

The first production Ford in 1903 had a zero electrical demand other than that for ignition as supplied by the magneto. In 1908 and 1910 the external appearance of the car had changed considerably, but headlights were still subject to the match rather than to an electrical switch when darkness descended. By 1915 the Model T had started the ladder of increasing electrical consumption with the addition of electrical headlights, albeit still supplied by the magneto. In 1919 Ford offered its first electrical system with starter, generator, and battery as extra-cost options to the basic hand-started vehicle.

From this time on there was a steady climb in required wattage: 75 watts in 1923, 91 watts in 1928, about 100 watts by 1931 with vairous accessories demanding more and more electrical power. The trend continued upward until the Second World War, with the 1942 Ford demanding approximately 250 watts.

Very little change took place during the "carless" war years, but the upward trend continued upon resumption of production in 1946. By 1950 the figure had climbed to almost 300 watts, and as we have seen it has grown even faster in the last few years.

With the release of the 1958 automobiles, the use of electrical power has increased to an even greater extent. Electric pumps for supplying air suspensions, torsion levelers, and similar items are now being used, as well as electric door locks and fuel pumps. As seen in Fig. 1, the electrical demand for the near future can be going no way but up.

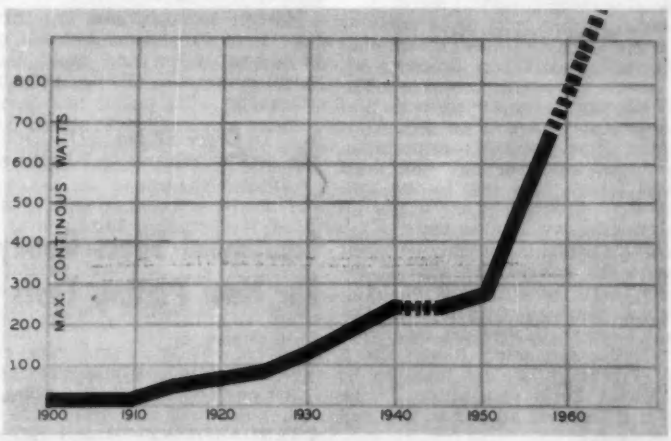


Fig. 1—Electrical demands, starting at practically zero in the early years, rose gradually until 1950, and then started to rise sharply.

Experience Helps Forecast Future Program Scheduling

Based on secretary's report by

J. SANFORD

Boeing Airplane Co.

ONE major contractor has developed a calculation for incorporating engineering and manufacturing estimates into a schedule plan.

First, the engineering effort that is estimated to be required for a new project is interpreted into jobs to be released during a specific time period. These data are then translated into a cumulative percent curve of engineering release during this time period. The next step is to measure the area beneath this curve. Fig. 1 presents an example of this curve with the area section shaded. This area is designated as the "cone of effort."

The area calculation yields a number. The significance of this number is in relation to numbers developed in the same way for previous programs. Successful programs in the past have indicated a "correct" number for new programs, another for growth models, and so on. Application of the cone-of-effort technique is dependent upon evaluating the engineering job content to define the program to be scheduled. Then the appropriate correct number is applied as a measure of reasonableness between the engineering release and manufacturing assembly schedules.

Using this area statistic to relate the manufacturing flow span to the release of engineering is accomplished by pegging the start of major assembly to that point in time where sufficient area lies beneath the engineering release curve to make the program reasonable in comparison to previous programs. Application of this technique is primarily dependent upon having schedules of prior programs available for review and analysis.

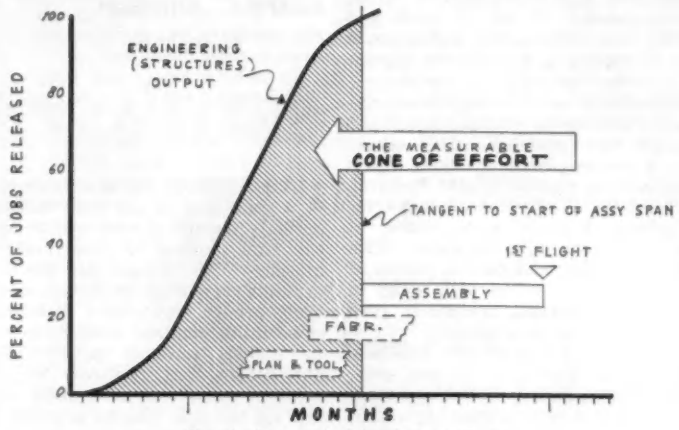


Fig. 1—Basic schedule—first airplane.

Others serving on the panel which developed the information in this article were: **F. W. Neale,** Boeing Airplane Co.; **D. F. Alcorn,** Douglas Aircraft Co., Inc.; **F. G. Knox,** Lockheed Aircraft Corp.; **V. L. Floore,** Solar Aircraft Co.; **W. R. Bradley,** North American Aviation, Inc.; and **M. E. Berry,** Northrop Aircraft, Inc.

To Order SP No. 321 . . .
on which this article is based, see p. 5.

R&D Contract Handling Complex

Excerpts from secretary's report by

K. M. JOHNSON

Convair Division, General Dynamics Corp.

THE best way to handle research and development contracts in general is by compromise, control, cooperation, competition, less red-tape, and good business sense. The key to the successful R&D program is the use of all these qualities without conflicts.

Because change is the only constant factor in the missile and aircraft industries, early procurement of long-lead-time items becomes a most important element in meeting schedules. But, fortunately, such items are a small percentage of the total to be dealt with. Early recognition of the problem is the real answer to the lead time bugaboo.

R&D programs often require special apparatus that cannot be maintained as an off-the-shelf item. So, it is particularly necessary to control communications at a single focal point between the buyer and vendor without harmfully restricting the scientist and/or the engineer.

Where test programs are involved, time is of the essence because of the keen competition and rapid technological progress in missiles and aircraft programs.

To Order SP No. 321 . . .
on which this article is based, see p. 5.

Equipment Specs Ready For New Plating Tests

Based on paper by

W. L. PINNER

Houdaille Industries, Inc.

STANDARDIZATION and calibration of two new tests for plated coatings are still to be completed by the Research Project of the American Electroplaters Society. The AES group has already developed to usable form, however, the two test procedures on which they have been working for several years:

- A new acetic acid modification of the salt spray test (ASTM B117–54T).
- A "Corrodkote" test.

Both of these tests (see SAE Journal, September, 1957, pages 121–122) are aimed to overcome valid objections to the long used salt spray test.

Data made available most recently from AES group's progress toward standardization and calibration include specifications for the equipment and method of conducting the new acetic acid modification of the salt spray test.

These specifications were written to include conditions within very narrow ranges, in comparison with existing ASTM rules.

To Order Paper No. 22B . . .
on which this article is based, see p. 5.

Small Car Invasion Offers No Threat Yet

Based on talk by

H. DREW
General Motors Overseas Operations

(Presented before SAE Mid-Michigan Section)

ENVIRONMENT has more influence on car design than car design has on environment. In Europe, the United Kingdom, and many areas to which their manufacturers export, the environment favors the small car with curb weight of less than 2400 lb. In the United States the small car accounts for only about 3% of total passenger-car sales, the environment favoring the larger car. But the demand for the small car is rising.

Instead of displacing the standard-size American car, the small car is more likely to penetrate the multicar owner market, in the main a new market superimposed upon the market for new and used standard cars. And for the time being, or until the demand can be gaged more accurately, those small cars will continue to come from abroad.

Unit Provides Trailers With Automatic Cooling

Based on talk by

GEORGE NELSON
Highway Refrigeration Co., Ltd.

(Presented before SAE Alberta Group)

THE Thermo-King transport refrigeration unit meets the following requirements:

1. It is light in weight.
2. It takes up little space.
3. It has a source of power independent of the tractor.
4. It has automatic control.

The unit attains lightness by such means as the use of aluminum for the frame and the compressor.

It has been kept as compact as possible by making it a one-piece self-contained package and by the use of a specially designed supercapacity compressor. The new RL model has a "pancake" shape, with the front section measuring 40% less than the previous model.

Power for this unit comes from a separately operated gas engine. Experiments are being conducted on models that use a hydraulic system rather than an internal-combustion system.

The Thermo-King unit is fully automatic. Stop-go engine operation is made possible by an integral starter-generator. This allows the unit to start when the trailer becomes warmer than desirable and shuts off when the desired temperature is reached. It automatically defrosts and unloads the water outside the trailer.

In winter, this equipment also serves, with the flip of a switch, as a completely automatic heating unit.

Complete controls with lights can also be put inside the tractor cab, to show the driver how the refrigeration unit is operating.

Taconite Process Up-Grades Iron Ore

Based on a talk by

FRED DEVANEY
Director of Metallurgy and Research, Pickands-Mather & Co.

(As reported by R. D. Chandler, SAE Central Illinois Section Field Eidtor)

TACONITE—as it is called locally in Minnesota—is a very hard rock, containing 20–30% iron. Of this 30%, about 22% is magnetic iron, which is the iron that is magnetically separated out and formed into the taconite pellets.

The Erie Mining Co. has built a $300,000,000 taconite processing plant in Minnesota north of Duluth at Hoyt Lakes. The capacity of the plant is about 7,500,000 gross tons of taconite pellets per year. These pellets contain about 64% iron. About 22,000,000 tons of taconite rock is mined and processed per year to yield this production of pellets.

The rock goes through four crushing stages down to pieces less than one inch in diameter. The taconite is then ground to final size (powderized) so that about 85% of the material will pass through a No. 325 mesh screen—about 105 openings per square inch. The iron is then magnetically separated into a concentrate and binding materials added. The concentrate is then rolled into balls about ¾ in. in diameter and baked in a furnace to harden them. The plant has 27 processing lines altogether. Storage space to stockpile about 4,000,000 tons of pellets over the winter is available.

Iron in this concentrated form is a boon to the steel industry. It is reliably estimated that the capacity of open-hearth furnaces is increased about 15% by stoking them with taconite pellets instead of ordinary iron ore.

This vast project is the result of over 22 years of research and development work. It has proved the feasibility of mining and processing low-grade iron ore—taconite. It has turned taconite, once considered a useless rock, into America's iron frontier.

Vertical Tail Aids Spin Characteristics

Excerpts from paper by

J. K. WYKES
North American Aviation, Inc.

THE vertical tail holds the most promise for effective results in designing good spin characteristics into an airplane.

Reasons include the fact that the vertical tail:

1. Is a primary source of directional damping. This damping affects favorably the yawing moments, which experience has proved most efficient in preventing or recovering from a spin.

2. Is a main source of directional stability—which keeps the all-important sideslip angle small.

3. Is a prime influence in determining the magnitude of the autorotational effects contributed by dihedral effect.

These attributes of the vertical tail, which help prevent spin and aid recovery, also help toward sufficient basic static directional and dynamic stability throughout the rest of the flight spectrum. This, in turn, helps to keep roll under control.

The designer, therefore, finds himself in a position to improve many flight characteristics at the same time—rather than having to improve one at the expense of another.

From a spin standpoint, the distribution of tail area should be such that as much as possible is below the fuselage. The fin area below the fuselage will, in most cases, be a region unblanketed by wake from other airplane components. In addition, the dihedral effect from the tail can be kept within reasonable bounds. Again, an added bonus is available from the below-the-fuselage tail location at supersonic speeds. The static directional stability with angle of attack stands to benefit.

If design compromises are such that tendencies to spin cannot be entirely eliminated, then primary control must be provided to permit quick recovery from a spin condition.

The most effective spin-recovery technique uses antispin yawing moments. The directional control, therefore, can be the most potent single control for use in spin recovery. It is a powerful influence on the sideslip angle. Therefore, it can oppose the spinning motion by providing the proper sideslip sense to utilize the opposing dihedral effect—as well as to provide a large yawing moment.

An all-movable vertical tail provides good directional control at both high and low Mach numbers . . . and makes the most efficient use of any unblanketed control area in a spin attitude.

To Order Paper No. 227 . . .
on which this article is based, see p. 5

SAC Has Grown Fast in 12 Years

Based on talk by

BRIG.-GEN. JAMES B. KNAPP
Director, Installations Engineering
Headquarters, Strategic Air Command

(Presented before SAE Wichita Section)

IN 1946 when the Strategic Air Command was organized under the leadership of Gen. George Kenney, it had about 600 airplanes, of which 250 were bombers. Only three were jet-propelled. The Command was situated on about 18 bases in the United States, and contained 37,000 people.

Today, barely 12 years later, SAC has upwards of 200,000 men, stationed at about 50 bases in the United States and overseas. It has over 2000 bomber and tanker aircraft. The greater proportion of them are jets.

SAC represents a monetary investment by the American people of $17 billion. Of this, some $11 billion is in the cost of real property and equipment; bases, aircraft, and all the miscellaneous hardware that is required to operate a military force. $6 billion represents the cost of training the men who comprise the real strength of SAC.

SAC Aircraft

SAC's heavy bomber is the 8-engine B-52, which is being accepted in the force to replace the B-36. The latter will probably be phased out completely during the coming year. The 6-jet B-47 has completely replaced the B-29's and B-50's and is now almost as well known as the Boeing B-17's and B-29's that were its predecessors.

The range extension possible with refueling in the air has proved so successful in the last 10 years that SAC is developing a sizable fleet of aerial refuelers. The experimental work was done with modified B-29's. The KC-97, a tanker version of the commercial Stratocruiser, became the standard refueling tanker. SAC is now beginning to accept into its units the KC-135, which is a tanker version of the Boeing 707. The all-jet bomber will enable aerial refueling at higher speeds and altitudes, thus further increasing the range of our bombing force.

Zytel Works Well In Heavy-Duty Jobs

Based on talk by

J. D. YOUNG
E. I. du Pont de Nemours & Co., Inc.

(Presented before SAE New England Section)

ZYTEL (or nylon molding powder) is being used successfully in a variety of heavy-duty jobs. Here are a couple of examples of nylon as a bushing material in really rugged service.

In one torsion-bar tandem-axle trailer the eight main hanger bushings and sixteen shackle bushings are made of nylon. In this case, the custom molder, working in cooperation with the engineering staff of the trailer manufacturer, developed a composition based on nylon which contained additives designed to impart certain characteristics. The entire load of this trailer, with all the shocks and vibration that go with hauling the trailer across country, is carried on the nylon bushings. Of course, they have been designed so that the unit loading is kept within the material limitations of nylon. In this particular application, these loads may reach 1800–2000 psi. It is interesting to note that, in the design of the main hanger bushing, a threaded section has been employed to give a greater load bearing area. This threaded section also serves as a thrust bearing surface. We understand that the previously used bushing required replacement every 25 to 50,000 miles of the trailer's life. With some of these nylon bushings, up to 100,000 miles of service life has been obtained and the upper limit is not known since bushings initially installed are still in service.

Another heavy-duty application for a Zytel bushing is in a certain brake camshaft assembly. The nylon bushing is economically produced by injection molding techniques. It does not rust or corrode and is unaffected by continuous operation to 250 F or in subzero temperatures. By adoption of this bushing, galling and brinelling of the brake camshaft through neglect of lubrication have been eliminated. Because of the resiliency of nylon, the bushings don't flatten out after long mileage.

System Simulation Helps Solve Complex Operations

Based on talk by

PATRICK J. ROBINSON
Imperial Oil, Ltd.

(Presented before SAE Montreal Section)

AN imitation of reality, in an attempt to see what might happen under conditions of real operation by doing a test on paper or in some other artificially limited fashion, is referred to as "systems simulation." We can attempt to do a series of experiments on a restricted basis, perhaps in a laboratory testing a physical model of the system. In management science we would usually use a manual or electronic computer to test a mathematical model, which can give us the feel and simulated results of real business activities without anything like the time, expense, and, more importantly, risks involved in experimenting with the actual business.

Simulation stems from the scientific method, which is basic to all true research. This type of activity is merely the outcome of trying to reason in a strictly logical fashion from initial hypotheses through various carefully designed experiments. What we try to do in simulating for research purposes is to develop, first, a crude, idealized system or model, and then through successive approximations and refinements we strive for a usefully close reflection of actuality. However, whether it is a model of a new aircraft or a mathematical model of a business or military operation, the model is put through its paces by being subjected to test conditions which closely resemble or simulate conditions which are anticipated for actual operation. By observing carefully the behavior of the model, whether it be physical or mathematical, we can gather some real insight into the likely behavior of the whole system under actual operating conditions. Naturally, if our simulation lacks certain basic elements of realism, or has distorted key relationships, we cannot hope to have a simulation worth using. In fact, herein lies one of the principal dangers to be avoided. If a thorough study cannot be made, it may be better to rely on judgment alone than to risk being misled by inadequate research.

In many cases where complex relationships, both of predictable and random natures, occur, it is easier to set up and run through a simulated situation than it is to develop and use a mathematical model representing the entire process under study. In many cases an activity can be affected by numerous random influences. The probabilities involved for each type of influence can be separately examined. However, the calculation of the probability of the combined sequence of activities spilling over into each other and interacting, in what is sometimes referred to as a cascading effect, leads into very deep mathematical waters in the field of Stochastic Process. This is simply a sophisticated technical phrase or piece of jargon covering involved problems of uncertainty.

To avoid an impossible or unprofitable attempt to solve a complex operation using equations to seek so-called optimal answers, we turn to a simulation of a system such that we

may repeatedly experiment and obtain statistically reliable emperical results. Sometimes we may use simulation or Monte Carlo techniques to firm up or verify complex theoretical analyses. A good synthesis of an operation might be thought of as a form of mathematical "sausage machine," grinding out the results for as long as we care to feed material into it. It is not simply a "better mousetrap" providing a "one-shot" proposition. It does not simply provide one answer. Rather it sets up a general framework within which we can, in a series of tests, run through months or years of experience to see what the likely outcome will be.

Simulation can be of considerable value for training purposes. It can also be useful in basic experimentation and in the evaluation of various problems. In addition, simulation techniques can tackle problems that are too cumbersome to be handled analytically. It can handle major systems or deal with rather small ones. The synthesis of a system is not dependent on how many details are put into it, but how many important factors are included. As long as no significant omissions exist, and as long as there is some empirical understanding of the various actions and interactions, a satisfactory model can probably be built for running simulation tests.

The input data to a simulation may be real or generated data. There may be a number of components in this simulation. We don't necessarily have to rely only on computers or desk calculaters, we can, in the case of, say simulation of a weapons system or some other complex arrangement build people into the system who will respond to various stimuli and will be part of the overall test. There are all manner of computers which may be employed in simulation. Digital computers with suitable programs are the types of equipment which generally will be applied, but all manner of special-purpose analogs or mixed equipment is feasible.

There are different types of simulation programs. The type which preprograms everything that is known about a situation, and fills in the answers to all the probable conditions which may arise, is very effective. It is not, however, as sophisticated as the type which permits the machine to do some form of elementary learning, such as a machine which learns the rules and plays a simple game of chess, or a simulation in which a certain amount of trial and error generates a body of experience which results in an improved play the next time a similar situation arises. The only basic difference in what we get from a simulation from what we get from an actual operation is that from a simulation the output is in the form of data which must be interpreted, and in an actual operation we get operating reports and frequently it is too late to do anything about recouping losses—we simply have to try to avoid similar losses again, or if we make a substantial profit somewhere we must try to determine what we did to get it, so that we may do it again.

Computer Forecasts Labor Hours and Manpower Needs

Based on secretary's report by

R. S. ROACH
Northrop Aircraft, Inc.

DOUGLAS Aircraft forecasts shop labor hours and manpower requirements from firm orders and schedules using a medium-scale Univac file computer with drum storage.

The input for this program consists of starting week, first and second peak weeks, completion week, total estimated hours, hours expended last week (if in process), sales order number, and identification code.

The program computes the personnel requirements and hours per week. This data is stored on the large-capacity drums by identification code and week.

Summary load forecasts are prepared by department, by groups of departments, by model, by fabrication category, by sales order, by sales orders in process, by various combinations, and by total plant.

Pending and projected loads are forecast for periods up to five years. And, experience shows that the forecasts deviated by only ±5% from the actual hours expended.

Serving on the panel which developed the information in this article, in addition to the panel secretary, were: **R. A. Phillips**, Northrop Aircraft, Inc; **W. P. Bamrick**, Douglas Aircraft Co.; **J. A. Morehouse**, Boeing Airplane Co.; **N. E. Johnson**, Lockheed Aircraft Corp.; **E. C. Yates**, Northrop Aircraft, Inc.; **C. J. Biddle**, Hughes Aircraft Co.; and **C. A. Phillips**, Department of Defense.

To Order SP No. 321 . . . on which this article is based, see p. 5.

Plated Steel Parts Do Best in Corrosion Test

Based on paper by

D. M. BIGGE
Chrysler Corp.

ON EXTERIOR automotive applications, plated steel parts perform better from a corrosion standpoint than do plated zinc-base die-cast parts. This is indicated in Table 1, which results from a survey made with seven makes of cars in the Spring of 1957.

The data show the effect of exposure time on plated steel and plated zinc-base die-cast parts used in exterior applications. They have been averaged to show the percentage of parts inspected which were rated "good" or better. ("Good" means acceptable to most people. A "good" part will have a few small corrosion spots—which would be undiscernable 15–20 ft away.

The table shows that on the 1954 cars the percentage of parts rated "good" or better was a little below the expected performance of such parts as compared with the ratings of similar parts on the 1955 and 1956 cars. The data pertain to plated steel bumpers and bumper guards and to plated zinc-base die-cast hood ornaments and headlamp doors.

The survey stresses the need for a new specification for the plating of zinc-base die-castings—although what that specification should be is not yet established.

To Order Paper No. 22A . . . on which this article is based, see p. 5.

Table 1—1957 Decorative Parts Corrosion Survey
(Seven makes of cars, three corporations)

	Material and Finish	Percentage of Parts Rated "Good" or Better Year of Manufacture		
		1954	1955	1956
Front Bumper	Steel—plated	67	87.5	94.2
Rear Bumper	Steel—plated	50	59.7	70.5
Bumper Guard—Front	Steel—plated	32.9	71.4	83.4
Bumper Guard—Rear	Steel—plated	38.9	70.7	90.1
Hood Ornament	Zinc die casting —plated	35.0	48.2	61.1
Headlamp Door	Zinc die casting —plated	38.4	45.8	64.4

Dull Nickel Undercoat Best for Chrome Plating

Based on paper by

C. H. SAMPLE
International Nickel Co., Inc.

RECENT observations with respect to the durability of decorative plating show that:

1. "Double-layer" buffed dull nickel-chromium coatings provide much better protective value in marine and rural atmospheres than do single-layer nickel-chromium coatings of the same total thickness. The double-layer coatings, however, provide little benefit in industrial atmospheres.

2. The protective value of bright nickel coatings under bright chromium is generally inferior to buffed dull nickel of the same thickness when exposed to the weather.

3. Increasing the thickness of bright nickel under chromium improves the protective value of the composite.

4. Chromium plating bright nickel may have an adverse effect on its protective value. However, increasing the thickness of the chromium from three to six times that normally applied has a marked beneficial effect.

The striking difference in effectiveness of the double-layer nickel coatings in the marine and rural versus the industrial atmospheres provides a possible clue not only to a means of directly improving the durability of decorative coatings but also sheds light on the mechanism of their failure in different environments.

It would appear that in pure marine and rural atmospheres, early failure of nickel-chromium and copper-nickel-chromium coatings results from existing porosity of some type, the exact nature or cause of which is not as yet known with certainty.

In industrial atmospheres, on the other hand, early failure may occur not only as a result of existing pores, but also as a result of pinholes created by intense localized corrosion of the nickel and copper by the atmosphere. On this basis the superior behavior of the double-layer nickel coatings in the marine and rural atmospheres can be ascribed to their relative freedom from initial porosity which would not be effective in severe industrial environments due to the rapidity with which pinholes can be created from the outside in.

Tests in which both bright and buffed dull nickel were included indicate that there can be a vast difference in the durability of the two types of nickel deposits. Indications are that the chromium-plated bright nickel tends to be inconsistent in its corrosion behavior and is generally inferior in protective value to buffed nickel of the same thickness. A marked improvement in protective value can be achieved, however, by increasing the thickness of the bright nickel (although performance still falls short of the buffed nickel).

Chromium plating bright nickel has, at times, an adverse effect on its protective value. This may be due to the phonomena of hydrogen embrittlement and hydrogen cracking of susceptible materials. It is well known, for example, that highly stressed high-strength steel may be caused to crack spontaneously when hydrogen is electrolytically discharged onto the stressed surface. Similarly, thin-walled, hardened "K" Monel tubes have been known to crack spontaneously when chromium plated. It is also well recognized that the susceptibility of materials prone to hydrogen cracking increases with increasing stress and hardness.

It is reasonable then to suspect that a hard bright nickel coating perhaps containing unduly high internal stresses might be susceptible to spontaneous hydrogen cracking when chromium plated. That thicker-than-normal coatings enhance the protective value of bright nickel-plated steel tends to support the hypothesis of spontaneous cracking. If the nickel cracks during the first few seconds of chromium plating, it is reasonable to expect that those early cracks might be filled or bridged with chromium by the time three to six times as much has been deposited.

To order Paper No. 22C . . . on which this article is based, see p. 5.

Lab Method Improved For Antiknock Rating

Based on paper by

I. A. CAPUTO
H. J. SEWELL
and
H. A. TOULMIN
Ethyl Corp.

RESEARCH octane number is the best single predictor of low-speed road performance (2000 rpm), and Motor octane number the best single predictor of high-speed performance (3000 rpm and higher).

If two laboratory variables are used as predictors, a combination of Research and Motor octane numbers serves best for predicting low-speed performance. At high speed, the combination of Motor octane number and per cent aromatics was found to be the best 2-variable predictor. Predictions based on either Research or Motor octane number plus a hydrocarbon-type variable (per cent olefins or per cent aromatics) resulted in slightly greater accuracy than was obtained with the combination of Research and Motor octane numbers.

Low-speed correlations based on Research and Motor octane number are not improved when olefin content is included as a third predicting variable. At high speed, however, the use of either olefin content or aromatic content in addition to Research and Motor octane numbers will significantly reduce the standard error of prediction. Data from the prototype-fuel program, in which the fuels were selected to give a wide variation in hydrocarbon composition, indicate that the standard error can be reduced by one-half when olefin content or aromatic content is included as an added predictor.

The use of more than three variables as predictors does not affect the accuracy of prediction at low speed and does not improve the accuracy at high speeds by a practical amount.

To Order Paper No. 260 . . . on which this article is based, see p. 5

Transition to Missiles Seen to Be a Gradual One

Based on a talk by

DR. HORTON G. STEVER
Massachusetts Institute of Technology

(As reported by R. S. Karlson, SAE Southern New England Section Field Editor)

THE missile program in both bombardment and defensive fields is growing. But the transition to missiles will be a gradual one, with development of both manned and unmanned craft continuing for years to come.

The bombardment missile, which is designed to replace today's long-range bombing planes may be either the air-breathing type or the ballistic type. The transition to these missiles will be gradual. We are still developing long-range jet bombers and, within the last 10 years, they have changed from 200-mph vehicles to sonic carriers incorporating the latest in automatic controls and equipment. These planes are complicated and expensive, but they do have the advantage of being subject to many complete and extensive tests simulating actual combat missions. This testing is much more difficult, and hence, much less complete in the case of missiles.

An additional advantage of the manned bombers is that of having a directing force that can think, reason, and change plans if necessary, rather than an electronic device which cannot be made subject to last-minute changes

or corrections. Thus, the transition to missiles in the bombardment group will include some work on better, faster, and higher, manned bombers as an integral part of the program. However, the so-called thermal barrier will eventually cause the jet bomber as we know it today to be left behind by the missile. Many problems must yet be solved on these pilotless units, but progress is constantly being made in the fields of rocketry, guidance, and servicing, as well as in developing accurate and dependable test procedures.

The defensive missile is one used in conjunction with many other defensive measures to protect against any type of enemy attack. Radar, of course, plays an important part in the defensive program, as does the fighter aircraft. The modern jet fighters are approaching missile proportions in themselves, with many automatically controlled operations, but they still retain the pilot to direct the complicated control system. Pilotless missiles also play a big part in the defensive system and their use is increasing constantly. The automatic target seeking missile is a potent weapon, but again has the disadvantage of being able to rely on much less complete test operation in comparison to piloted craft.

At the present time we have a gap in our defensive system in that we do not have a good defense against the ballistic missile. We can, and must, take advantage of several weak points inherent in the ballistic missile in order to defend ourselves against it. (1) It contains no intelligence, is like a dinosaur in this respect. (2) It follows a simple, easily plotted trajectory. (3) It is usually extremely hot so it can be traced by heat-seeking homing devices.

Electrical Analogies Help Analyze Mechanical Impedance

Based on paper by

R. K. COOK
National Bureau of Standards

THE impedance of linear mechanical systems can be examined by using equivalent electrical circuits. In general the correspondence is mass → inductance; viscous resistance → electrical resistance; spring constant → /capacitance; force → voltage; velocity → current. This is Maxwell's analogy. It holds for fundamental mass-spring-dashpot systems and can be applied to filters and transducers of the piezoelectric and electrostatic types.

A mobility analogy must be used for a moving coil transducer. The correspondence is: force →current; velocity → voltage; mass → capacitance; viscous resistance → 1/electrical resistance; spring constant → /inductance.

Not all systems can be represented by an electrical analogy. Examples are the gyroscope and continuously elastic materials, which cannot be represented by lumped parameters.

To Order Paper No. 200 . . . on which this article is based, see p. 5.

Vane-Type Blower Looks Ideal on Paper

Based on talk by

RALPH KEAST
Canadian Kenworth, Ltd.

(Presented before SAE British Columbia Section)

ON PAPER, the vane-type blower looks as if it would make an ideal supercharger because of the moderate power draw, mixture temperature, and good low-speed boost. Some early vane-type designs suffered from having the vanes rub directly on the casing, which caused heavy friction and rapid wear, required just the right amount of lubricant mixed with the fuel, and was awfully finicky about dust in the intake air. Modern designs, however, have the vanes swinging on a shaft and pivoting on trunnions in the eccentric drum. This holds a small clearance between the vanes and the casing and eliminates most of the bugs.

But there's still one extreme disadvantage. Because of unbalanced rotating forces and other mechanical stresses peculiar to this type of compressor, you don't dare turn it much over 4000–5000 rpm. To get the airflow and boost pressures we need for 300-plus cu in. engines, without turning the blower unit above, say, 5000 rpm, the thing would have to be as big as an ashcan! When we're thinking in terms of 20–30 psi or more boost, the vane-type blower is out of the question, except for engines of very moderate displacement.

How It Operates

The vane-type compressor is a weird cross between the centrifugal and Roots layouts as regards its compression process. Part of its compression is done adiabatically by squeezing down the volume of an air slug at high speed, as on the centrifugal. Part is done more or less isometrically by ramming the slug into the manifold air mass.

An eccentric drum inside a circular casing is rotated while vanes sliding up and down in slots in the drum sweep air around the casing from inlet to outlet ports. Since the volume of the air slug between any two vanes decreases as it moves around the casing, part of the compression, maybe half, depending on the design, is actually accomplished before the outlet port is uncovered. The rest is done on the Roots principle by positive displacement. Thus, the power requirement for compressing a given quantity of air per minute to a certain final pressure lies somewhere between that of a centrifugal and a Roots blower. So does the mixture temperature rise. The volumetric efficiency characteristics here are similar to the Roots, so there is some useful pressure available in the low and medium rpm ranges. Due to differences in airflow and the part-adiabatic compression, maximum boost is not sharply limited as on the Roots, pressures of about 30 psi are successfully used with one compression stage.

Vapor-Phase Cooling Has Many Applications

Based on talk by

M. L. BAKER
Engineering Controls, Inc.

(Presented before SAE St. Louis Section)

VAPOR-phase cooling systems—which control engine temperature by allowing the circulating water to boil—has a variety of applications.

The simplest, lowest-first-cost, controlled-temperature cooling system that could be applied to an engine would consist of gravity circulation of the cooling system between the engine and a flash boiler steam separator. The heat rejected to the engine jacket would all be wasted to the atmosphere, as latent heat of the vapor, and 100% make-up would be required to replace the lost vapor. This system is particularly adaptable to purely standby units, and a large number are used by telephone companies, hospitals, the Atomic Energy Commission, and others. It is obviously not suited to general everyday use, as the continual addition of untreated make-up water would leave large quantities of scale and other solids in the system, and the use of large quantities of soft water or treated water is usually too expensive.

The addition of a shell and tube condenser to the circuit would make it a closed system, with no loss of jacket water under normal operation. The condenser must be mounted above the water level of the unit and the operation is restricted to nearly atmospheric pressure. We find many applications

for this system in marine work, with irrigation pumps, oil pipeline pumping stations, and in Kobe oil plants.

Where the use of the waste heat requires a certain preset pressure or where a constant temperature of a heated product is essential, or a process is to require some, but not all, of the heat produced, a pressure-regulating valve or back-pressure valve may be used. This permits the excess steam to be bypassed to a condenser system. In this type of application the condensate is usually returned to an open or vented receiver, by gravity flow, and pumped back to the jacket system as required. The standby condenser can use air, water, or product for a cooling medium.

Speeding Solution Of Mechanical Problems

Based on paper by

E. L. HIXSON
and
A. F. WITTENBORN
University of Texas

KNOWLEDGE of electrical circuits can be used to help solve mechanical vibration problems. Impedance is the common denominator.

Mechanical impedance is tough to calculate in complex systems, therefore it is measured directly. Computer techniques speed the results.

Transference of the impedance concept, long used in electrical circuit analysis, to mechanical systems is justified because analogous differential equations represent both electrical and mechanical systems. And with the impedance concept go all the circuit rules, theorems, and mathematics developed for the analysis of electrical networks.

The equivalent circuit concepts, especially Thevenin's and Norton's theorems, lead to a great saving in time in the analysis of a complicated system. Instead of solving the complete set of equations of motion, the external characteristics, that is, internal impedance and free velocity, or clamped force, can be measured at the point of interest and the equivalent circuit thus obtained used in the solution of the particular problem.

There is a multitude of dynamic, vibrational, and shock excited mechanical situations that can be analyzed. The impedance of soils should be useful in such problems as the foundations of machines, highways, and airfield runways. In large structures, such as buildings and bridges, impedance measurements on models could lead to a better prediction of the dynamic characteristics of the structure. In aircraft structures the impedance analysis should be useful every time a device is attached to the air frame. This would be true for small instruments as well as the engines themselves. Equivalent circuits would allow vibration isolation mounts to be designed specifically to eliminate troublesome components of vibrational energy. At the same time, the characteristics under landing shocks can be determined.

Instrumentation required for impedance, velocity, and force measurements is not extensive. Many aircraft companies have suitable vibration exciters, load cells, and vibration pickups in their environmental and flight testing organizations. Once the method has been instrumented a great variety of problems can be handled with a better understanding of them and a great saving of time.

To Order Paper No. 202 . . . on which this article is based, see p. 5.

Ups and Downs in Welding Nodular Iron

NODULAR iron lugs can be welded to a nodular iron ring—provided a full anneal is possible following the welding. Without a proper subsequent anneal, the welds may show heat-affected zone hardness up to 600 Brinell. The anneal needed is one of 1650 F, slow-cooled to 1350 F, held for 5 hr, and then slow-cooled from there down.

Most welding of nodular iron is still confined to repair or salvage operations. It isn't yet advisable, for example, to try to join nodular iron to formed steel parts in fabricating structural components.

Nodular iron and cast iron, on the other hand, can be welded satisfactorily with a preheat of 1100 F—when gas welding is employed. While gas welding is preferable in this application, arc welding has been used successfully . . . with 55-nickel electrodes and a preheat of 300–600 F. (Nodular and gray cast iron can be welded in approximately the same way. But gray iron's relative lack of ductility requires more care in slow-cooling to avoid restraint.)

— Consensus at an SAE Production Forum Panel on "Welding Methods and Process Control"—Albert J. Dearing, A. O. Smith Corp., secretary

To Order SP No. 320 . . . on which this article is based, see p. 5

Evaluation Method Spots Automation Opportunities

Based on secretary's report by

MURRAY D. BRAID
Thompson Products, Inc.

DETERMINING what process and to what extent it should be automated is usually the function of the methods group. One tool which helps them spot likely automation opportunities is the evaluation outlined in the following six steps:

1. Define the improvement possibilities presented by an automated system.
2. Establish the allowable amortization period.
3. Make photographs of the present operation to aid in analyzing mechanization of the operation.
4. Determine the equipment specifications.
5. Build a trial model and mockup of any questionable part of the operation. This permits experimenting with ideas before they are actually built into the machines.
6. Estimate the cost of the project taking into account such things as the necessity for backup facilities, trouble shooting aids, and special control panels.

Also serving on the panel "Have You Decided to Automate?", which developed the information in this article, were J. A. Newton, Thompson Products, Inc.; Prof. Powell Niland, Washington University; R. L. Witsche, International Harvester Co.; and Fred Jessup, Cincinnati Milling Machine Co.

To Order SP No. 320 . . . on which this article is based, see p. 5

Good Design, Not Styling, is Fleet Need

Based on secretary's report by

M. K. SIMKINS
Chilton Co.

TRUCK fleet men who exchanged ideas at a recent Transportation Meeting cried a unanimous "Aye" to the proposition:

"We want good, simple basic design in our vehicles—and we don't care about styling."

Even a city delivery fleet operator said: "Fleet vehicles should be designed more specifically for the job for which

Continued on page 114

Daughter Receives Heldt's 50-Yr. Plaque

Miss Elizabeth Heldt (below) receives the 50-year SAE Certificate of Membership plaque awarded to the late Peter M. Heldt, her father, on December 5, 1957, from Metropolitan Section Chairman Robert M. Cokinda. An editorial Mr. Heldt wrote was responsible for the organization of SAE in 1905. He was then editor of "Horseless Age."



Others who received 25- and 35-year Certificates of Membership were: 35-year Certificates, E. H. Delling, W. Barton Eddison, Frank P. Herman, Mario L. Luiggi, James D. Mooney, William B. Wachtler.

25-year Certificates, M. Gould Beard, George H. Freyermuth, Joseph K. Honigman, N. A. Jorgensen, Francis Kettaneh, Martin S. Mansson, Victor F. Massa, Francis MeVay, Matt E. Nuttila, John J. Powelson, John Butler Rosenquest, Walter A. Toepel, F. W. Von Meister, Will Walter White.

New Membership Promotion Folders

"Materials Engineers" and "Fleet Maintenance Men Want to Know" are two new SAE membership promotion folders.

Aimed at particular groups of engineers in the automotive and aeronautical industries, these folders are a brief introduction to the work of SAE and the benefits of Society membership.

These folders have been distributed to Sections and Groups and members of Engineering Materials and Transportation and Maintenance Activity Committees, who plan to use them as display pieces at meetings, in plants and businesses, or as a mailing piece to prospects.

Copies are available from Sections and Membership Division, SAE Headquarters.

1958 SAE National Meetings

- March 4-6
  Passenger Car, Body and Materials Meeting, Sheraton-Cadillac Hotel, Detroit, Mich.

- March 31-April 2
  Production Meeting and Forum, The Drake, Chicago, Ill.

- April 8-11
  Aeronautic Meeting, Aeronautic Production Forum, and Aircraft Engineering Display, Hotel Commodore, N. Y., N. Y.

- June 8-13
  Summer Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

- August 11-14
  West Coast Meeting, Ambassador, Los Angeles, Calif.

- September 8-11
  Farm, Construction and Industrial Machinery, Production Forum, and Engineering Display, Milwaukee Auditorium, Milwaukee, Wis.

- September 29-October 3
  Aeronautic Meeting, Aircraft Production Forum, and Engineering Display, Ambassador, Los Angeles, Calif.

- October 20-23
  Transportation Meeting, Lord Baltimore Hotel, Baltimore, Md.

- October 21-24
  Diesel Engine Meeting, Lord Baltimore Hotel, Baltimore, Md.

- November 5-6
  Fuels and Lubricants Meeting, The Mayo, Tulsa, Okla.

S·A·E CEP

COOPERATIVE ENGINEERING PROGRAM NEWS

Kelley Appointed Chairman Of 1958 Technical Board

9 Start 3-Year Terms



Board Chairman Kelley

OLIVER K. KELLEY has been appointed chairman of the 1958 Technical Board by SAE President W. K. Creson.

An SAE member for 32 years, Kelley has been active in Society affairs. During World War II, he was war-time chairman of SAE's Committee on Transmissions and Clutches and Drive Lines—Captured Enemy Equipment. Kelley has also been chairman of the Hydrodynamic Drive Nomenclature Subcommittee, Transmission Committee, and Detroit Section Greenbrier Committee.

In addition to committee work, Chairman Kelley has presented a number of papers on automatic transmissions at SAE national meetings. He is currently chairman of Symposiums on Automatic Transmissions for SAE Meetings.

Kelley's professional career began in 1927 when he joined the Cadillac Motor Car Division of General Motors. In the years which followed, he played an important part in the development of the original Synchromesh and Hydramatic transmissions. He also worked on rear-engine coach design, engines, drive line and transmissions, brakes, and controls.

In 1940, Kelley was honored as a "Modern Pioneer" by the American Manufacturers Association for notable achievements in the automatic transmission field.

As a member of GM's Engineering Staff in 1950, Kelley continued to work on automatic transmissions for passenger cars, heavy-duty commercial vehicles, and U. S. Army military vehicles.

Currently, Board Chairman Kelley is chief engineer at the Buick Motor Division.

The following men joined the 1958 Technical Board along with Chairman Kelley.

PETER ALTMAN is currently the SAE Presidential Advisor on Small Engines. He has been a member of the SAE Council and, until recently, was chairman of the Small Aircooled Gasoline Engine Subcommittee of the Engine Committee. In 1942, Altman became Vice President of the Aircraft Activity Committee. Prior to this, he served as chairman of the Detroit Section.

Altman taught aeronautical engineering at the University of Detroit from 1925–40. He became the director of the Aeronautics Department in 1934.

Altman joined Vultee Aircraft, Inc. in 1941, and in 1948, began his current association with Continental Motors Corp. in his present capacity as a vice president.

E. C. BROWN has been active in SAE technical committee work as a member of various subcommittees of the Construction and Industrial Machinery Technical Committee. He is co-chairman of the CIMTC's Tractor Drawbars and Tire and Rim Simplication Subcommittee.

A graduate of MIT, Brown became assistant chief engineer at Austin-Western Co. in 1931. In 1942, he was appointed to his present position as chief engineer.

In recent years, Brown has been engaged in developing a new hydraulic crane which has proved valuable to the material handling industry.

MUIR L. FREY is a member of the 1958 Meetings Committee and the Technical Board Publication Policy Committee. In 1957, he served as SAE Vice President of Engineering Materials. Frey has participated in Iron and Steel Technical Committee work for over 12 years.

In 1923, Frey graduated from the Missouri School of Mines and Metallurgy, University of Missouri, with a M.S. Met. E. (cum laude). He subsequently joined the Holt Mfg. Co., Gerlinger Electric Steel Casting Co., John Deere Tractor Co., Republic Steel Corp., and the Aircraft Division of Packard Motor Car Co.

Frey is currently a member of the staff of the vice president for manufacturing, Tractor Group, Allis-Chalmers Mfg. Co.

G. J. HUEBNER, JR. joins the Technical Board not only as a new member, but also as a member of the Board's Executive Committee. Huebner's other Society activities include being general chairman of SAE's 1958 National Passenger Car and Body Materials Meeting to be held next month in Detroit. In addition, he is the SAE representative at the National Academy of Science and a member of the Passenger Car Activity Committee. In 1957, Huebner served as vice president of the Board

of Directors of the Coordinating Research Council, Inc.

Huebner is well known for the part he played in developing Chrysler's regenerative gas turbine which first appeared in a 1954 production model Plymouth.

After World War II, Huebner became chief engineer of Chrysler's Research Section. Under his direction, a 1000-hp turboprop engine was developed for the U. S. Navy.

Huebner is currently the executive engineer in charge of Chrysler's Research Section.

ANDREW A. KUCHER has been appointed a member of the Technical Board's Executive Committee. He is one of the founders of SAE's Nuclear Energy Advisory Committee.

As vice president of engineering and research at Ford Motor Co., Kucher directs all product engineering, research, and testing activities. Before joining Ford in 1951, he acted as vice president in charge of research at Bendix Aviation Corp. Prior to this, Kucher was manager of research engineering at the Frigidaire Division of General Motors.

Kucher developed the first sealed-unit refrigerating machines in addition to one of the first all-fresh air-conditioning units.

JOHN W. LARSON is assistant chief engineer at Chance Vought Aircraft, Inc., Dallas. After graduation from the University of Utah, with a B.S. degree in mechanical engineering, he joined Curtiss Aeroplane and Motor Co. as designer and assistant project engineer.

Larson's association with Vultee Aircraft Corp. began in 1934 as a design group engineer. In the years which followed, he became assistant project engineer, project engineer, chief of design engineering, assistant chief engineer, and chief engineer.

Larson joined Chance Vought in 1954 in his present position.

Former SAE President **ARTHUR NUTT** was one of the original members of the Technical Board which was formed in 1945. A Society member for over 35 years, he served as President in 1940, Councilor in 1944, and member of the 1957 Board of Directors of the Coordinating Research Council. A former Vice President of the Aircraft Powerplant Activity, Nutt is currently a member of the Aeronautics Committee and chairman of the Special Aircraft Project Division of the Aeronautics Committee.

In addition to being vice president of engineering at Lycoming Division, Avco Mfg. Corp., Nutt holds over 12 aircraft motor patents.

E. B. OGDEN is a 1958 SAE Councilor and the 1958 Vice President for Transportation and Maintenance. As a 16-year Society member, Ogden has been particularly active in technical committee work. Among the technical committees on which he has served are the Transportation and Maintenance Technical Committee, the Truck and Bus Technical Committee, and the Brake Committee.

Ogden's present association with Consolidated Freightways, Inc. began in 1932. Since then, he has acted as superintendent of shops, superintendent of maintenance, and director of research and development until his appointment as vice president in charge of equipment development.

Remaining on the Technical Board are the following members whose terms expire at the end of 1958.

C. F. Arnold, Cadillac Motor Car Division, General Motors Corp.
Trevor Davidson, Bucyrus-Erie Co.
W. H. Graves, University of Michigan
W. M. Holaday, Special Assistant to Secretary of Defense for Guided Missiles.
A. E. W. Johnson, International Harvester Co.
C. L. Sadler, Sundstrand Aviation Division, Sundstrand Machine Tool Co.
D. D. Streid, Jet Engine Dept., General Electric Co.

Members whose Technical Board terms end in 1959 are:

A. P. Fontaine, Bendix Aviation Corp.
R. H. Isbrandt, American Motors Corp.
M. J. Kittler, Holley Carburetor Co.
W. M. May, Mack Trucks, Inc.
R. W. Rummel, Trans World Airlines, Inc.
E. C. Smith, Republic Steel Corp.
E. C. Wells, Boeing Airplane Co.
A. E. Williams, Freuhauf Trailer Co.

1958 Board Chairman Kelley has selected the following Board members to serve on the Executive Committee:

C. F. Arnold — **A. A. Kucher**
G. J. Huebner, Jr. — **C. L. Sadler**
A. E. W. Johnson

The six men whose three-year terms on the Technical Board just ended are:

L. L. Bower, Waukesha Motor Co.
A. T. Colwell, Thompson Products, Inc.
R. F. Kohr, Ford Motor Co.
A. G. Loofbourrow, Chrysler Corp.
E. F. Norelius, Construction Engineer.
A. E. Smith, Pratt and Whitney Aircraft Division, United Aircraft Corp.


Altman


Brown


Frey


Huebner


Kucher


Larson


Nutt


Ogden

30 Technical Committee Members Awarded Certificates of Appreciation


Kinnucan


H. G. English


McCortney


Fisher


Haynes


Gallagher


Hobelmann


Phillips


Belitsos


Glynn

THIRTY SAE technical committee members were awarded Certificates of Appreciation for outstanding contributions toward furthering the development of technical information and specifications used by the aeronautical and automotive industries. At a January 16 luncheon in Detroit, Technical Board Chairman Johnson cited achievements of the following men:

J. W. KINNUCAN has been a significant link between SAE aircraft engine committees and AIA's Engine Technical Committee. He has participated in SAE Aircraft Engine Division work since 1941, and for the past 11 years, has been a member of the Small Commercial Aircraft Engine Standards Committee.

H. G. ENGLISH led the work of clarifying nomenclature and terminology of hydrodynamic drives. A member of the Transmission Committee, English has been engaged in the development of functional definitions of laboratory and road test terminology as well as parts nomenclature.

W. J. McCORTNEY has been the main spring behind cooperative engineering between the rubber and automotive industries. As a result of his work, rubber classifications exist which are similar to the highly successful steel classifications appearing in the SAE Handbook. In addition, McCortney has led the Nonmetallic Materials Committee on such projects as hydraulic brake fluids and coolants.

HAROLD FISHER, a former Screw Threads Committee chairman, has focused attention on the unification of screw thread standards and the consolidation of nuts and bolts specifications. In addition, he aided in the development of Dryseal pipe thread standards now widely used in automotive and allied industries.

A. L. HAYNES has provided outstanding leadership as chairman of the Motor Vehicle Seat Belt Committee. In addition, he contributed comprehensive technical test data used to formulate the SAE Recommended Practice on Motor Vehicle Seat Belts. Haynes also led the SAE Committee which worked with the Atomic Energy Commission some years ago on the effects of an atomic explosion on automobiles.

E. S. GALLAGHER has successfully worked out procedural handling of SAE aircraft electrical equipment specifications with other interested technical groups and the government. As chairman of the Aircraft Electrical Equipment Committee, Gallagher has expanded his committee's service in the military specifications area.

A. H. HOBELMANN has been chairman of the Pneumatics Subcommittee of Aircraft Committee, Hydraulic and Pneumatic Equipment, since 1950. For the past three years he has been a member of A-6's Hydraulic Pumps, Motors, and Air Compressors Subcommittee. Hobelmann's efforts in the direction of minimum performance requirements for fire extinguishers for aircraft have been notable.

R. W. PHILLIPS' experience with aircraft hydraulic and pneumatic fittings and hose has been invaluable in solving industry and Service problems. Since 1955, he has been chairman of the Aircraft Fittings and Flexible Hose Assemblies Committee. Phillips is also chairman of the Coded Fittings Subcommittee of the Tube, Pipe, Hose, and Lubrication Fittings Committee.

P. G. BELITSOS has fostered SAE drafting standards since 1950. More recently, he helped organize the Joint Aeronautical-Automotive Drawing Standards Committee of which he is


W. P. English


Zimmerli


Cross


Lundquist


Carrigan

Members Appreciation

currently chairman. From 1954–57, Belitsos served as chairman of the Aeronautical Drafting Manual Committee.

F. K. GLYNN has brought SAE philosophies and practices in standardization to the attention of the ASA Standards Council in his capacity as SAE representative. He has coordinated this activity with SAE technical committees and the Technical Board. Glynn completed his ninth term as SAE representative in 1956.

W. P. ENGLISH played an important part in the development of military aircraft parts standards during his 10-year participation in the work of the Engine and Propeller Standard Utility Parts Committee (E-25). A former E-25 chairman, English has also been a member of the General Standards for Aircraft Engines Committee (E-21).

F. P. ZIMMERLI, who is a leading figure in the shot peening area, has served on the Iron and Steel Technical Committee Executive Committee for a total of eight years. He was chairman of the ISTC Shot Peening and Blast Cleaning Division from 1953–56, in addition to being a member of the Ordnance Specification, Residual Stresses, and Seam Depth Divisions.

W. L. CROSS, JR. has been an active and constructive participant in the work of the SAE Lighting Committee for more than a dozen years. He is director of the Division of Engineering of the Connecticut Motor Vehicle Department and his contributions as a state official using SAE Lighting Standards have been most valuable.

W. G. LUNDQUIST has functioned as the administrator of the Aircraft Engine Division since his appointment as chairman three years ago. A former Technical Board member, Lundquist has been a member of the Aeronautics Committee since 1956.

C. E. CARRIGAN contributed much toward making AMSs practical engine documents during his 16-year participation in AMS Division activities. From 1953–1956, Carrigan acted as secretary of the Carbon and Low Alloy Steels and Titanium Commodity Committee.

D. E. BATESOLE was instrumental in reorganizing the bearings section of the SAE Handbook into a logical sequence of overall bearing dimensions. Through his efforts, SAE became interested in American and international standardization, while Batesole was chairman of the Ball and Roller Bearing Committee for 13 years. He also effected a close SAE liaison with the Anti-Friction Bearing Manufacturers' Association.

A. E. MILLER has been active in SAE standardization of oxygen equipment due to demands created by high-altitude commercial transports. Miller continues to work on performance requirements for oxygen equipment as chairman of the new Aircraft Oxygen Equipment Committee.

C. C. HUDSON's diplomatic efforts resolved the test code problems of vehicle-mounted worm-gear winches. More generally, Hudson has catalyzed the cooperative thinking of the Transportation and Maintenance Technical Committee of which he is a member.

C. M. DEAN is responsible for broadening the scope of currently available technical information on radio interference problems associated with ignition systems. While Dean was chairman of the Radio Interference Subcommittee of the Ignition Research Committee, studies were conducted on cause and effect of such interference. Dean is now chairman of the IRC.

W. G. AINSLEY implemented the development and construction of the CLR-ELD Oil Test Engine. As chairman of the Coordinating Research Council group that executed this work, Ainsley brought together divergent opinions on a test program which is of direct interest to SAE's Fuels and Lubricants Technical Committee.

WILLIAM HERTEL contributed heavily toward the development of the new 45° SAE Flared Fitting Standard. A

Continued on next page



Dean Ainsley



Hertel Emery



Haeusler Smith



DeSmet Roush



Monsch Beltz



Batesole



Miller



Hudson



Klatt Mozley

Certificates . . .

Continued from page 97.

member of the Tube, Pipe, Hose, and Lubrication Fitting Committee, Hertel was also involved with the testing of the "O" Ring Fittings and Flareless Fittings Standards.

E. G. EMERY, JR. brought to completion a series of aircraft drive pad standards which were developed during his chairmanship of AE-1's Accessory Drive Panel. These specifications make engine drive pads compatible with engine drive accessory mountings. Emery has also participated in the activities of the Aircraft Electrical Committee; Aircraft Starters Committee.

ROY HAEUSLER took a leading part both in the development of the original Recommended Practice for Motor Vehicle Seat Belts and the most recent revision. Haeusler's contributions on the anchorage problem were particularly significant.

A. H. SMITH has fostered the close relationship which exists between SAE's Iron and Steel Technical Committee and the American Iron and Steel Institute. A former chairman of the ISTC Executive Committee, Smith has also represented the ISTC and SAE at Washington conferences on the continuous marking of steels.

E. C. DeSMET instigated much of the body engineering material which now appears in the SAE Handbook. He was one of the founders of the Body Engineering Committee and served as chairman from 1945–55.

R. W. ROUSH recently implemented the development of a new steel specification for heavy-duty brake drums. Prior to this, he led the Iron and Steel Technical Committee group that worked with the Detroit arsenal on military gear problems. Roush has been a member of the ISTC Executive Committee as well as chairman of the ISTC.

H. D. MONSCH has done an outstanding job of handling and supervising a complete and thorough revision of the Wrought Aluminum Alloy Section of the SAE Handbook. Monsch is currently chairman of the Wrought Aluminum Alloy Subcommittee of the Nonferrous Metals Committee.

L. L. BELTZ has contributed much to SAE Handbook reports on spark plugs, radio vehicle interference, and headlights. He has also represented SAE on the ASA Sectional Committee on Inspection Requirements for Motor Vehicles and the U. S. National Committee on Definitions of Electrical Terms.

W. E. KLATT spearheaded an exchange of thinking between the Engine Committee's Clutch Housings, Clutch Mountings, and Flywheels Subcommittee and various Construction and Industrial Machinery Technical Committee groups. As chairman of the former, Klatt aided the development of mutually acceptable standards for flywheel housings, flywheels, rear mounting pads, clutches, and power take-offs.

P. P. MOZLEY pioneered the first titanium alloy specifications ever to be established while chairman of AMSs Carbon and Low Alloy Steels and Titanium Commodity Committee. Mozley has also encouraged the expansion of AMSs into the airplane area.

New ARP Shows Mounting Designs For Small Electric Power Motors

INCREASED use of miniature power motors in all types of aircraft has led to SAE development of designs for mounting power motors rated at 1/20 hp and below. The designs are now available as Aeronautical Recommended Practice 569, Drive-Miniature Power Motor with Involute Spline-Pinion.

Since low-horsepower motors are used extensively in the control of trim surfaces, throttles, lockpin actuators, valves, doors, and oil cooler mechanisms, a need arose for standardization. Thus, at the request of the Aeronautical Standards Group, Departments of the Navy and Air Force, the Motors Subcommittee (shown below) of SAE's Aircraft Electrical Equipment Committee (A-2) undertook the job of establishing the unique designs which appear in ARP 569.

Advantages of the new document include:

- Pinions can be used as splines where gear reduction is not required.
- Square, round (synchro type), or face mountings can be used.
- Ball bearing ODs can be used to provide the pilot, thus minimizing shaft runout.
- Weight is decreased by use of minimum size increments which eliminate gap in hp ratio between one frame size and another.
- Smaller pinions promote maximum gear reduction and save space in motor shaft.

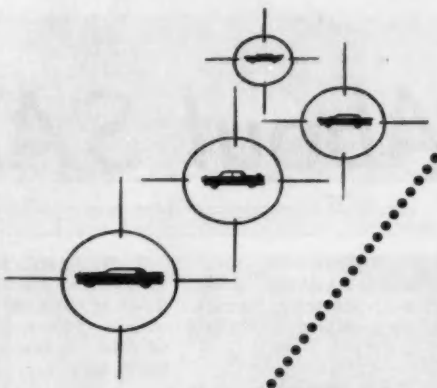
In developing ARP 569, the Motors Subcommittee used the following as guide points:

- Existing motor sizes.
- Uniformity in size ranges.
- Power input.
- Power output.
- American-British-Canadian Standardization Group Recommendations.
- ARP 461, Synchro Specification.

Electric Power Motor Group Developes New ARP



SAE national passenger car, body, and materials meeting



march 4–6, 1958

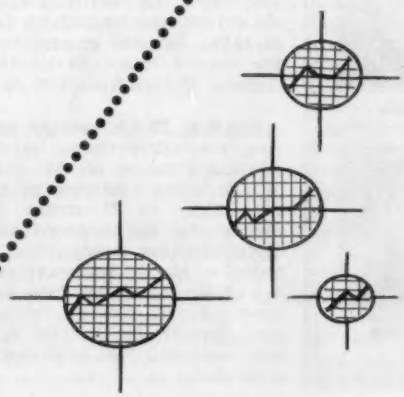
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- tire horizons
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- automatic transmissions and limited slip differentials

panel
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symposium
- significant developments in 1958 engines

the sheraton-cadillac hotel
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march 31–april 2, 1958

SAE national production meeting and forum

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panels:

automation in assembly
coordination between engineering and manufacturing
what's new in foundry techniques?
quality control—how much can you afford?
quality and quantity in production heat treating
what can a computer do for production?
manufacturing cost control
numerical control

technical sessions:

abc's of computers
modern adhesives
abc's of operations research
economies in production forming of metals

the drake, chicago, illinois

About SAE Members

MALCOLM P. FERGUSON, president of the Bendix Aviation Corp., since 1946, has been elected a member of the board of directors of United States Rubber Co.

IVAN CALICOAT has been made manager of technical service for Dana Corp. in Toledo, Ohio. He has been with the corporation since 1946, most recently as manager of its aircraft gear plant in Fort Wayne, Ind. In his new capacity, Calicoat will be responsible for coordination between the manufacturing and engineering divisions in all matters affecting the quality of Dana products for the automotive and transportation industries, and their performance in the field.

JEROME OTTMAR, formerly general manager of the Nuclear Products Division of Metals & Controls Corp., has become president of M&C Nuclear, Inc. The Nuclear Products Division has been reorganized and renamed M&C Nuclear, Inc., and is a wholly-owned subsidiary of Metals & Controls Corp.

CHARLES W. WULFF has been made manager of original equipment sales for Purolator Products, Inc., in Rahway, N. J. He has been with the organization since 1947 and held the post of original equipment engineer in Purolator's Chicago office for the past six and one-half years.

VINCENT R. HERTERICK has been appointed executive assistant to the president of United-Carr Fastener Corp., Boston, Mass. Formerly he was a vice-president of the Ucinite Co., division of United-Carr in Newtonville, Mass.

R. KENNEDY SMITH has become sales manager for the Elco Lubricant Corp., Cleveland; formerly he was in engineering and technical service with the Lubrizol Corp.

KIRKE W. CONNOR has been elected chairman of the board of the Micromatic Hone Corp. in Detroit. Connor previously served as president of the corporation, which he founded in 1929.

URBAN T. KUECHLE has been made vice-president in charge of all phases of the Automotive Division, A. O. Smith Corp. Formerly he was vice-president in charge of sales for the division.

J. R. PARKER, formerly the division's chief engineer, has been named director of sales and engineering. He will be responsible for quality control, product engineering, and sales and order service.

EDWARD H. FISHER has been elected president of Tube Reducing Corp., Wallington, N.J. He joined Tube Reducing recently, having been associated previously with the Oliver Corp., Chicago, as vice-president and manager of its Special Products Division.


Ferguson

Calicoat


Ottmar


Wulff


Herterick


Smith


Connor


Kuechle


Fisher


Hartmann

DONALD H. HARTMANN has been made assistant general manager of the Moto-Mower Division of Detroit Harvester Co., Richmond, Ind. For the past year, Hartmann has been assistant to the president of Detroit Harvester with headquarters in Detroit.

ROBERT E. LAKE, formerly director, research and development, Penn Electric Switch Co., is now director, technical services, International Division, Whirlpool Corp., St. Joseph, Mich. He has assisted in organizing subsidiary corporations of Whirlpool and is vice-president of both Whirlpool International of Canada and of Switzerland. In his new position he is responsible for all engineering pertaining to all Whirlpool International corporations.

ROY T. HURLEY, chairman and president of the Curtiss-Wright Corp., has been elected to New York University's Board of Trustees. Hurley joined Curtiss-Wright in 1949 and was elected chairman of the board in 1952.

He sponsored the first SAE Aeronautical Production Forum in 1953, and at the request of the U. S. Air Force, guided the first comprehensive study in the history of the aviation industry on the machinability of metals.

FRANK H. IRELAN has retired as general manager of Delco Products Division of General Motors Corp. at Dayton, Ohio. He had held this position since 1940 and started his GM career in 1916. He was general manager of the former Delco Brake Division of General Motors from 1937 to 1940.

IDAN E. FLAA, account representative, the Ethyl Corp., has been appointed manager of the oil activities of the Tulsa Chamber of Commerce for 1958. In November Flaa was among the recipients of gold award certificates for outstanding service in behalf of the Oil Information Committee of the American Petroleum Institute. **F. H. RHEES,** vice-president and director, Sinclair Oil & Gas Co., will work with Flaa as department vice chairman.

RAYMOND G. HILLIGOSS has become division lubrication engineer with the Phillips Petroleum Co. in Atlanta, Ga. Formerly he was a lubrication engineer with the company in Wichita, Kan.

Hilligoss has been 1949–50 chairman of SAE Mid-Continent Section, chairman of the Transportation and Maintenance Committee, and 1941–42 Student advisor to the SAE Student Branch at Oklahoma A & M College.

MICHAEL J. SCOVELL is secretary-treasurer of County Tile and Supply, Ltd., and technical adviser to County Construction Co., Ltd., both subsidiaries of Maritime Asphalt Products, Ltd., of which he is sales manager. The companies are located in Summerside, Prince Edward Island, Can. Previously Scovell was equipment division manager with M. F. Schurman Co., Ltd.

MARTIN J. STOLTZ has retired as manager, equipment sales, with Purolator Products, Inc., Rahway, N.J., and is now living in Boca Raton, Fla.

GEORGE F. CHOATE is now a distributor for the Seaside Oil Co. in San Jose, Calif. Formerly he was with the Union Oil Co. in industrial sales engineering.

SUMNER MEISELMAN, supervisory general engineer of the Military Motor Transport Division, Office Chief of Transportation, U.S. Army Transportation Corps, has been awarded a Department of the Army Research and Study Fellowship. He will engage in graduate engineering work at the University of Michigan, and has chosen for his fellowship project, the study of "land locomotion" and the effect of the "granular mass" upon the mobility of off-road equipment.

OLIVER E. SPENCER has returned to Leeds and Northrup Co., New York City, as a junior field engineer. For the past two years he has been a design engineer with the U.S. Air Force in Washington, D.C.

ROBERT E. STREMMEL is now a project engineer, development engineering department, Aviation Division, Sundstrand Machine Tool Co., Rockford, Ill. Formerly he was a liaison engineer with McDonnell Aircraft Corp., St. Louis, Mo.

THOMAS H. POYER, formerly an engineer with the Ford Motor Co. in Detroit, is now an engineer for the General Electric Co. in Utica, N.Y.

PHILIP H. STEWARD is now assistant to the vice-president of manufacturing with Microdot, Inc., South Pasadena, Calif. Formerly he was design engineer for Gilfillian Bros., Inc., Los Angeles. In his new position he assists in setting up a statistical sampling plan for quality control.



Wells Kinzel Colbert Mitchell De Fino



Harris Randall Johnson Orr

EDWARD C. WELLS, vice-president —engineering, Boeing Airplane Co., has been elected president of the Institute of the Aeronautical Sciences for 1958. He succeeds **MUNDY I. PEALE**, president of Republic Aviation Corp.

New IAS vice-presidents include **NEIL BURGESS**, manager, J-79 Project, General Electric Co.; **L. EUGENE ROOT**, vice-president and general manager, Lockheed Missile Systems Division; and **R. DIXON SPEAS**, aviation consultant, R. Dixon Speas Associates.

DR. AUGUSTUS B. KINZEL, vice-president of Union Carbide Corp., has become president of the American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc.

LESTER L. COLBERT, president of Chrysler Corp., has been awarded the 1958 Gold Medal of Achievement by the Poor Richard Club. He was chosen for this honor because of the achievements attained by Chrysler Corp. in merchandising, advertising and marketing during the past year.

WALTER G. MITCHELL has been made general manager of product development for the Thor Power Tool Co. He will integrate engineering operations of all Thor divisions and subsidiaries and will assist all divisions with field engineering problems. Mitchell joined Thor in 1941, became chief engineer in 1943, and director of research and engineering in 1946.

ANTHONY J. De FINO has been elected vice-president of Hupp Corp. in Cleveland. Formerly he was vice-president and general manager of the All-Year Air Conditioning Division of Servel, Inc., Evansville, Ind.

WILLIAM H. HARRIS, JR., has become executive vice-president of the Micromatic Hone Corp. in Detroit. He has been chief engineer at Micromatic since 1941, was made vice-president in charge of engineering in 1952, and was elected to the board of directors in 1953.

JOHN S. RANDALL has been elected vice-president in charge of industrial products with the A. O. Smith Corp. He has been with the corporation since 1952, and prior to his new position was manager of the automotive products group.

WILLIAM R. JOHNSON has been made chief research metallurgist at the research center of Associated Spring Corp., Bristol, Conn. He will be responsible for the basic research carried on at the center directed toward application of new and improved materials and advanced metallurgical processing techniques to problems of spring design and fabrication. Johnson has been research metallurgist for the corporation's Wallace Barnes Co. Division since 1953.

F. J. ORR has been appointed a director of Somerville, Ltd., in Toronto, Ont., Can. He has been with the company for 25 years, and is general manager of the Panel Division with plants in Scarborough and Windsor.

RUSSELL S. ATKINSON is now sales manager for the National Water Lift Co., Division of the Cleveland Pneumatic Tool Co., where he directs the advertising and sale of the company's products on a world-wide basis. Formerly Atkinson was sales manager, Lear-Romec Division, Lear, Inc.

THOMAS H. WIGGINS, formerly an engineer with Harley Earl, Inc., Center Line, Mich., is now a designer for Republic Steel Corp., Cleveland, Ohio.

ROBERT G. MINTY is now component development test engineer with Continental Aviation and Engineering Corp., Detroit. Prior to this he was engineering aide—field testing of military prototype vehicles, with the U.S. Army Ordnance Corps, Aberdeen Proving Ground, Md.


Wolkenheim


Vickers


Dougherty


Gaskin


Hardgrove

STANLEY E. WOLKENHEIM has been elected vice-president in charge of marketing with the A. O. Smith Corp. He has been associated with the corporation since 1949 and became corporate director of marketing in 1955, a post held until his recent election as vice-president.

THEODORE G. VICKERS has been named plant manager of the Ross Operating Valve Co. in Detroit; formerly he was manager of manufacturing research and development for the Kelsey Hayes Co. in Jackson, Mich.

T. E. DOUGHERTY has become assistant chief engineer (administration) for the Chevrolet Motor Division, General Motors Corp. He joined the division in 1932 and has been a staff engineer and director of experimental manufacturing and vehicle building since July, 1956.

D. C. GASKIN has been named executive vice-president and general manager of Mack Trucks of Canada, Ltd. Formerly president of Studebaker-Packard of Canada, Ltd., he will have charge of all Mack operations in the Dominion, with headquarters in Toronto.

THOMAS H. HARDGROVE, formerly plant engineer of Aerojet-General Corp., has joined the management Staff of the Anaheim Division of Northrop Aircraft, Inc., as chief plant engineer. Hardgrove has been active in SAE Student activities, serving as faculty advisor of the California State Polytechnic College Chapter from 1948 to 1954. He was also Student activities chairman of Southern California Section in 1955–56.

CMDR. G. O. NOVILLE, USNRF Ret., has been named president of Townsend Engineered Products, Inc., a new research and development subsidiary of Townsend Co. Noville formerly was president of G. O. Noville & Associates as well as its founder.

SAMUEL L. SOLA, formerly chief engineer for G. O. Noville & Associates, has become vice-president—engineering for the new subsidiary.

JAMES H. MUNGER has been appointed to a new sales territory by the Garlock Packing Co., in southern Michigan, northern Indiana, and parts of northern Ohio. Formerly Munger operated out of the firm's Detroit office.

JOHN L. COLLYER, chairman of the board, the B. F. Goodrich Co., recently spoke at the annual meeting of the Rubber Manufacturers Association. He stated that 63 per cent of the new rubber used in the United States this year will be man-made, a peacetime record.

SAMUEL K. HOFFMAN, general manager of the Rocketdyne Division, North American Aviation, Inc., in Los Angeles, has been elected a vice-president of the company. Hoffman come to North American in 1949 as chief of the Aerophysics department's propulsion section, and was named to his present position of division manager in June, 1954.

WALTER H. SIMPSON, formerly general manager, parts and equipment Division, Ford Motor Co., is now owner of Gondola, Inc., in Ypsilanti, Mich., a cocktail lounge and restaurant.

RALPH H. DuBOIS is now general manager of Microtech Corp., a subsidiary of Federal-Mogul-Bower Bearings, Inc., Pasadena, Calif. Formerly he was regional sales manager of Bower Roller Bearing Division of the corporation in Detroit.

JOHN A. SAHS, formerly tractor product planning analyst, Tractor and Implement Division, Ford Motor Co., is now senior engineer, Engineering Division, Chrysler Corp., Detroit.

FRANCIS PAUL DEAN, JR., formerly research engineer, Ford Motor Co., Dearborn, Mich., is now a mechanical engineer with the Texas Co. in Beacon, N.Y.

JOHN C. HUEBNER, formerly assistant project engineer, Propeller Division, Curtiss-Wright Corp., Caldwell, N.J., is now service engineer, Transport Division, Boeing Airplane Co., Renton, Wash.

WILLIAM H. THOMAS, JR., sales manager since 1946 for Cleveland's Pressure Castings, Inc., has become vice-president for development at Kenyon College. In his new position he will be responsible for all financial development at the college.

R. D. HIGH has been made production manager of the new Manila plant of the Firestone Tire and Rubber Co. Formerly he was departmental production manager, Firestone Tire and Rubber Co. of India, Ltd.

HAROLD F. MITCHEL, chief engineer of U.S. Graphite Co., Saginaw, Mich., has been named to the powdered metal products subcommittee of the SAE Nonferrous Metals Committee, representing the technical committee of the Powder Metallurgy Parts Manufacturers Association.

JOHN A. PETHO is now supervisor, sales engineering — molded products, with the Continental-Diamond Fibre Corp., a division of the Budd Co. Previously he was supervisor, engineering, with the corporation.

HAROLD G. VAUGHAN has retired as president of the Muskegon Piston Ring Co., Muskegon, Mich. He has been with the company for more than 30 years and will continue as a director; he has also been named vice-chairman of the board.

Fuller Appointments


Niness


Packard


Butler

Fuller Mfg. Co., Transmission Division, Kalamazoo, Mich., has announced several changes in personnel responsibilities.

W. E. NINESS, vice-president, formerly in charge of sales, now holds a staff position in preparation for his retirement, which will take place in 1958.

J. A. PACKARD, formerly manager, original equipment sales, has been made general sales manager. In this capacity he will be responsible for both sales and service.

L. C. BUTLER, formerly in service sales, is now assistant to the general sales manager.

ARTHUR L. HAUBERT is now a sales engineer for the Colorado Kenworth Corp. in Denver. Previously he was secretary-treasurer and sales manager with Motor-Kool Radiator Service Inc.

BORIS M. OSOJNAK has become a project engineer with Chrysler Corp. in Detroit; formerly he was assistant to the vice-president of engineering with Heyl and Patterson, Inc., Pittsburgh.

HOWARD J. JANSEN, formerly assistant manager, systems engineering, Rockets Division, Bell Aircraft Corp., Buffalo, N.Y., is now coordinator of associate contractor development, Denver Division, The Martin Co.

Jansen has been active in SAE Buffalo Section, having served as secretary-treasurer, vice-chairman, and 1956–57 chairman.

EDWARD G. DINGMAN, formerly senior materials engineer, The Martin Co., Baltimore, Md., is now research director with the Macallen Co., Inc., Newmarket, N.H.

DAVID L. CLIFF is now an automotive engineer, product/volume planning, Export Division, Chrysler Corp., Highland Park, Mich. Formerly he was an automotive engineer, staff quality control, manufacturing, with Chrysler in Detroit.

STEPHEN J. ROGERS, formerly assistant quality control manager, Ford Division, Ford Motor Co., Dearborn, Mich., is now staff assistant to the manufacturing manager with Ampex Corp., Redwood City, Calif.

EARNEST R. HARRISON, formerly general manager with Coach Parts, Inc., Atlanta, Ga., is now sales manager for Southern Coach Parts, Inc., Birmingham, Ala.

JAMES E. GAUSE is now a graduate student trainee, Education Division, Westinghouse Electric Corp., Pittsburgh, Pa. Formerly he was with the U.S. Army in Huntsville, Ala.

DAVID H. RUHL, formerly general manager, Cummins Diesel Sales Corp., Denver, Colo., is now president of Cummins Northeast Diesel Sales, Inc., Albany, N.Y.

LOUIS GRABILL, formerly an engineer with Northrop Aircraft, Inc., Hawthorne, Calif., is now a project engineer for J. I. Case Co. in Churubusco, Ind.

HERBERT G. HOEFLER, JR., is now chief engineer, Automotive Division, Standard-Thomson Corp., in Boston. Formerly he was assistant to the general sales manager, Clifford Mfg. Co. Division of the corporation in Waltham, Mass.

A. W. JUDGE, consulting automobile engineer of Farnham, Surrey, Eng., is the author of "Engineering Precision Measurements"; in the third edition of this standard work, he keeps pace with the constant developments in engineering and industry.

Four new chapters of the book cover Slip Gauges, Straightness and Flatness Measurements, Interferometric Methods, and Surface Finish. Also included is an account of Automatic Gauging and Work Sizing.

NORMAN L. GEBHART has become manufacturing manager of the Moraine Products Division of General Motors Corp. Formerly he was director of purchasing and material control, and has been with GM since 1925.

WINSTON E. WINTERBOURNE is now actively engaged in the business and administration of the Cloud Co. of Hayward, Calif., of which he has been part owner for the past eight years. Previously he was chief development engineer for the Oliver Tire and Rubber Co. in Oakland. He has been active in SAE Northern California Section, where he has been membership chairman, placement chairman, 1955–56 secretary, and alternate delegate to the Sections Committee for 1956–57.

WESLEY F. KOFAHL, formerly an electro-mechanical designer with the Stromberg Carlson Co. in Rochester, N.Y., is now a missile powerplant en-

Continued on page 112

Obituaries

FRANK A. BEST . . . (A'34) . . . retired, 1957 . . . formerly president, Standard Products of Canada, Windsor, Ont. . . . died Oct. 20 . . . born 1886 . . .

HARRY G. BOLTON . . . (M'41) . . . chief engineer, Marvel-Schebler Products Division of Borg-Warner Corp. . . . had been with the company since 1928 . . . died recently . . . born 1905 . . .

FRANK S. BRYAN . . . (A'49) . . . sales engineer, Standard Oil Co. of California Western Operations, Inc. . . . had been with the company since 1939 . . . died Nov. 26 . . . born 1920 . . .

ARCHIBALD G. DANIELSON . . . (M'25) . . . assistant chief engineer, Diamond Motor Car Co. . . . had been with the company for 37 years . . . retired, July, 1956 . . . died Oct. 27 . . . born 1895 . . .

THOMAS Z. FAGAN . . . (A'26) . . . director of sales, service, and advertising of the Scintilla Division, Bendix Aviation Corp. . . . had been with the division since 1922 . . . died Dec. 6 . . . born 1890 . . .

DAVID J. GILES . . . (M'28) . . . senior vice-president, Latrobe Steel Co. . . . had been with the company since 1919 . . . died Jan. 6 . . . born 1890 . . .

JOHN J. KOHL . . . (A'22) . . . chairman of the board, International Tool Co. . . . formerly president of the company . . . died Sept. 18 . . . born 1890 . . .

LLOYD B. LITTLE . . . (M'47) . . . assistant to president, International Union of Operating Engineers; formerly director of maintenance, Summit Fast Freight, Inc. . . . died Sept. 2 . . . born 1901 . . .

RUSSELL E. MacKENZIE . . . (M'22) . . . executive engineer for automotive products section of the Bendix Products Division, Bendix Aviation Corp. . . . formerly with Studebaker Packard Corp. . . . died Dec. 9 . . . born 1898 . . .

FURBER I. MARSHALL . . . (A'28) . . . president of Carlisle Corp. since 1948 . . . chairman of board of Dart Truck Co., and member of board of Stoner Rubber Co. . . . died Sept. 29 . . . born 1895 . . .

P. T. NAUDET . . . (M'46) . . . director of technical research, Consumers Cooperative Association . . . worked with the National Refining Co. as petroleum chemist and technologist . . . later become chief petroleum engineer, manager of lubricating oil and grease department for CCA . . . died Dec. 11 . . . born 1900 . . .

JAMES ROBINSON . . . (M'56) . . . chief engineer of Vickers, Inc., division of Sperry-Rand Corp. . . . had been with the corporation since 1930 . . . died Dec. 15 . . . born Scotland 1904 . . .

A. R. RUTH . . . (M'43) . . . assistant maintenance superintendent for Halls Motor Transit . . . formerly maintenance superintendent for York Motor Express Co. for 33 years . . . died Oct. 31 . . . born 1905 . . .

RAYMOND SHAW . . . (A'41) . . . president and founder of Chek-Chart Corp. . . . created Chexall Corp., subsidiary of Chek-Chart . . . died Dec. 8 . . . born 1893 . . .

PETER J. SHUTTLEWORTH . . . (J'56) . . . mechanical engineer, General Motors Proving Ground, General Motors Corp. . . . received BSME degree from Case Institute of Technology . . . died Oct. 16 . . . born 1934 . . .

Rambling . . .

THROUGH THE



FUELS and Lubricants meeting of the **KANSAS CITY SECTION** was held November 21, 1957, and featured John F. Dickman (above) of E. I. du Pont de Nemours & Co. and his presentation entitled, "The History of the Development of Gasoline Anti-Knock Compounds."

FUTURE PLANS and organizational developments of the SAE were discussed by 1957 SAE President W. Paul Eddy at the December 12, 1957, meeting of the **SOUTHERN NEW ENGLAND SECTION.** Eddy also presented, at the meeting, 35-year Certificates of Membership to Fayette Leister and Roy S. Sanford.

Edwin A. Nichols, technical chairman for the meeting, introduced Guest Speaker Elwood L. Byrkett, assistant manager of Standard Industrial Products Division, The Sheffield Corp. The paper was on "The Science of Measurement," a digest of which will appear in a future issue of the Journal.

The question period, following the presentation, included a blackboard-illustrated description of the operating principle of the Sheffield air gauge, and a discussion of the type of measurements which can be made with the gauges. Actual machining tolerances and fits used on several parts in the automotive industry were also covered in the discussion following the paper.

Section Chairman Roland Blakeslee presented Speaker Byrkett with a Section Certificate of Appreciation for his paper, at the conclusion of the meeting.

IMPORTANT ELEMENTS in the use of the air-cooled engine principle when applied to diesel engines, with special emphasis on the military aspects, was reviewed by C. F. Bachle, vice-president in charge of research, Continental Aviation and Engineering Corp., at the December 11, 1957, meeting of the **TWIN CITY SECTION.** The talk, "Air-Cooled Diesel Engines," also included common misconceptions of the advantages and disadvantages of air-cooled engines, with illustrations from Continental's experience.



Bachle also showed a movie which dealt with military applications of Continental's air - cooled diesel engines. Examining the film are, left to right, Section Chairman D. D. Hornbeck, Speaker C. F. Bachle, and Section Vice - Chairman A. L. Preston.

"JET TRANSPORT OPERATION—Nationally," was the topic of the guest speaker, Ray D. Kelly, superintendent of technical development, United Air Lines, Inc., at the November 18, 1957, meeting of the **SOUTHERN CALIFORNIA SECTION.** Before Kelly's presentation, J. E. Gainer, manager of operations, American Airlines, Inc., posed a series of questions relative to the airport handling of new jet transports. A technical digest of Kelly's paper will appear in a future issue of the Journal.

Coffee Speaker Gainer opened the meeting by pointing out that the jet is a new thing with the airlines, "It is not just another series of the same ship, but brand new, with brand new problems, planning and headaches." He outlined some areas where special attention must be given . . . such as handling of jet ships in terms of fueling and equipment, personnel hazards, baggage handling, maintenance, and training problems.

In the general discussion of commercial jet operation that followed the formal presentations, the following points were made:

- Ingestion of foreign articles into the engine is expected to be a potential problem.
- A system where the passengers, cargo, and baggage can be exchanged, the cabins cleaned, food stores boarded, and the ship refueled in a one-hour interval, was believed possible.
- Most major cities will have adequate facilities for handling jet transports by 1960.
- Pre-load baggage containers, which were not successful on the DC-6 because of the technical problem in the aircraft attachments and hangars, are a good probability for the DC-8.

SECTIONS

HIGHLIGHT of the December 10, 1957, meeting of the **DAYTON SECTION** was a special commendation presented to Frank H. Irelan upon the occasion of his retirement from general managership of Delco Products Division, General Motors Corp. Irelan was honored for his great contributions to the Section, which at one time he was largely responsible for reviving. In response, he told of early days in the automotive business and the early formation of the Dayton Section.

Main speaker of the meeting was



George W. Jackson (above), of Delco Products Division, GMC, who discussed "The General Motors Air Suspension." His presentation dealt with the design of the air spring, the compressor and its application, and the functions and operation of the different control devices in various GM systems.



Appearing at the speakers table (left) are C. J. Werner, Moraine Products Division, GMC, left, and F. H. Irelan, retiring general manager of Delco Products Division, GMC, right.

ANNUAL Fuels and Lubricants Meeting of the **MID-CONTINENT SECTION** was held December 6, 1957, in Bartlesville, Okla. Members and guests from all over the state attended the meeting, featuring Robert V. Kerley, director of the Products Application Division, Ethyl Corp. "Fuel Additives and Engine Durability" was the topic of the evening, with Kerley showing the effect of various concentrations of additives on valve life and spark plug fouling. Following the illustrated talk, in the question period, a great deal of interest was shown by the engineers in the phenomenon called "rumble."

See page 114 for a technical digest of this presentation.

Shown below are Speaker Robert V. Kerley (middle) discussing fuel additives with Section Vice-Chairman Warren L. Thompson (left), and Section Chairman Frank E. DeVore (right).



AIRPLANES are the machine tools which enable airlines to produce the ton-miles and passenger-miles from which the revenue is derived . . . but before the vastly increased production capacities of the jet transport can be fully realized, the entire civil air transport system, and especially the ground facilities and surface transportation, must be geared to this increased productivity. This is what Ray D. Kelly, superintendent of technical development, United Air Lines, Inc., told members of the **NORTHERN CALIFORNIA SECTION** and the **SOUTH BAY DIVISION** at a joint aviation meeting on December 11, 1957.

Kelly's talk, "Jet Transport Operation—Nationally," was the first half of a double bill and was followed by the presentation of "Jet Transport Operation—Internationally," by John G. Borger, chief project engineer, Pan American World Airways, Inc. Borger explained to the audience how Pan American engineering teams met with the plane manufacturers to develop design features aimed at overcoming the special problems encountered in overseas flight.

Technical digests of these papers will appear in a future issue of the Journal.

ENROLLED students of the **OREGON STATE COLLEGE STUDENT BRANCH** took a field trip December 13, 1957, from Corvallis to Portland where they visited both the Owens-Illinois Glass Co. and the Hyster Co. At noon, between visits to the two plants, the students were luncheon guests of **OREGON SECTION.**

"AIR SUSPENSION on Highway Tractors," including the problems that have to be solved in the development of a successful air suspension system for heavy-duty road equipment, was discussed by John G. Locklin at the November 25, 1957, meeting of the **CINCINNATI SECTION.** Locklin is with advance design engineering, GMC Truck and Coach Division.

Rambling . . . THROUGH THE

INCREASED attendance at the **BALTIMORE SECTION** meetings is reported this year—and a look into some of the reasons proves interesting. It is felt that this boom reflects the growth of the Section itself—a growth which is evident in many ways.

One of the most significant signs of this growth has been the addition of technical activities . . . just a few years ago a Fuels and Lubricants Activity took its place with Aircraft and Transportation and Maintenance Activities . . . and this year Diesel Engine Activity joined the ranks. Next year the Baltimore Section will play host to the National Diesel Engine, Transportation, and Maintenance meetings, another step indicating the Section has "come of age."

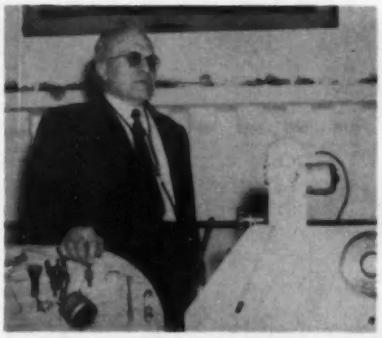
These National meetings, it is reported, have already had indirect effects on the Baltimore Section and might well be one of the reasons for this year's spirited attendance. Frequent meetings of the Governing Board—planning Section Activities, and planning for the National meetings—has proved to be a boost to the Section, as well as to the Society as a whole.

ST. LOUIS SECTION'S December meeting featured M. L. Baker, chief engineer, Engineering Controls, Inc. For a digest of this presentation, entitled "Vapor Phase Cooling Systems," see page 91.

"PRACTICAL SLANTS on Engine Bearing Usage" was presented December 2, 1957, at the **ATLANTA SECTION** meeting. Speaker of the evening was Walter E. Thill, chief engineer of the service bearings department of Federal-Mogul-Bower Bearings, Inc. Thill serves as membership vice-chairman of the SAE Transportation and Maintenance Activity Committee.

An added feature of the night's program was the presence of members of the Georgia Institute of Technology SAE Student Club.

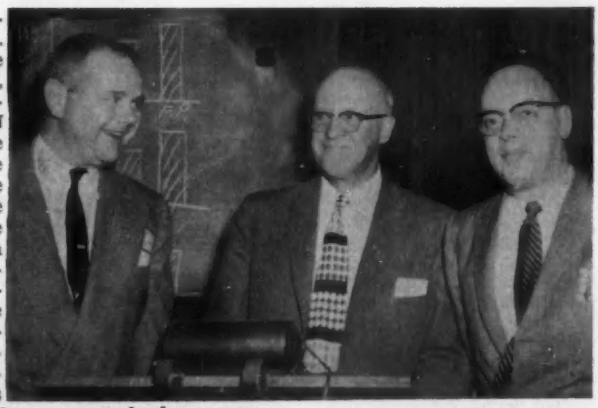
THE SPEED-O-STAT was the topic of the **INDIANA SECTION'S** December 12, 1957, meeting . . . combining past-chairman meeting and student meeting nights. SAE Past-President Ralph R. Teetor, (left), inventor of the Speed-O-Stat, was guest speaker, discussing with the SAE'rs the device, which is currently being offered by Chrysler Corp. as optional equipment under the name Auto-Pilot. The speaker described how his invention provides automatic throttle control, acts as speed reminder, and enables the motorist to cruise without exerting foot pressure on the accelerator.





Greeting Mrs. Jane Sundling, vice-president of Laboratory Equipment Corp., and Indiana Section's only lady member are, left to right, G. P. Stonecipher, service manager, Perfect Circle Corp.; A. W. Herrington, chairman of the board of Marmon-Herrington Co., Inc.; and W. L. Rodgers, Section representative, National Nominating Committee.

SAE Past-President C. G. A. Rosen spoke December 6, 1957, at the **MILWAUKEE SECTION** meeting on "The Influence of the Turbine on the Future Vehicle Power Plants." He discussed high pressure ratio supercharging of piston engines, the compound powerplant, the gas turbine itself, and nuclear powerplants utilizing a turbine for power, and solar energy.



Appearing with Speaker C. G. A. Rosen (middle) are, Milwaukee Section Chairman E. H. Panthofer, left, and Section Program Chairman D. R. Neeld, right.

SECTIONS



MONTREAL SECTION Vice-Chairman D. J. Munro and Mrs. Munro (left), and Section Chairman J. T. Dyment and Mrs. Dyment (right), gather at the Section's second annual Ladies Night held December 5, 1957. Over 75 couples enjoyed the evening, consisting of cocktails, buffet dinner, entertainment, and dancing.

"LOCAL TALENT" spoke at the December meeting of the **CENTRAL ILLINOIS SECTION** . . . topics and speakers were: "Logging in the Great Northwest," by Richard H. Hunger, staff engineer of Caterpillar Tractor Co.; "Electronic Computers Solve Engineering Problems," by Ralph King, staff engineer of Caterpillar Tractor Co.; and "Requirements of Braking," by Jim Tripp of LeTourneau-Westinghouse Co.

Hunger stated in his talk that the advent of the logging arch was a boon to the logging industry . . . because the arch lifted one end of the logs off the ground, and the economical skidding distances were lengthened considerably. The trend, Hunger pointed out, is definitely toward smaller tractors and the resulting shorter skid distances, in an attempt to further reduce the total cost of getting the logs out of the woods.

General procedures for solving engineering problems on electronic computers was briefly outlined by King . . . the general procedure in a hydraulics system problem is to diagram the hydraulic system, the knowns and unknowns; translate the hydraulic system into an equivalent, theoretical mechanical system; then build an "electronic model" and plug it into the analog computer through the electric components which add, subtract, change signs, differentiate, and integrate.

Tripp discussed the present and future needs of service brakes in modern, high-speed, earthmoving equipment. He stated that current field reports indicate that at the present time, the best brakes are none too large. The most serious need is for a more efficient means of dissipating the heat generated when braking a machine to a full stop.

Gathered at the meeting, below, are, left to right, Speaker Richard H. Hunger; Rudolph K. Polak, Section past-chairman; R. P. VanZandt, meeting coffee speaker; Speaker Jim Tripp; F. E. Kronenberg, meeting technical chairman; and Speaker Ralph King.



WHAT TO EXPECT from wet and dry types of air cleaners in automotive service was discussed by H. M. Turner of the Donaldson Co., Inc., at the November 4, 1957, meeting of the **SALT LAKE GROUP.** Some of the important points brought out in the paper, entitled, "Air Cleaners—The Why of Wet or Dry," were:

The criterion for cleaner selection is adequate engine protection from dust for the service encountered, with the capacity for low service or maintenance cost. Extreme variations in the severity of service dictates the need for several types of cleaners . . . the extended surface dry paper type filter has the advantage of high efficiency for dust removal, but the disadvantage of short life in severe service . . . the wet or oil-washed type provides high capacity but is not as efficient for dust removal . . . the composite dry air cleaner comprising a cyclone separator primary, followed by a paper cartridge secondary, has the advantage of long service life and high efficiency, but has the highest first cost.

Inlet position and shapes of inlet piping affect cleaner performance. Locate inlet away from crankcase vent, high heat areas, and avoid inlet piping shapes which create high turbulence. High turbulence and centrifical action break down normal agglomerates of fine particles and lower overall cleaner efficiency.

"ENGINEERING The Edsel" was the topic presented at the January 6, 1958, meeting of the **ATLANTA SECTION.**

Speaker of the evening was William E. Burnett, executive engineer of the Edsel Division of Ford Motor Co. Burnett's illustrated presentation included the Edsel automatic brake lining adjustment, air suspension, speed warning indicator, steering wheel push button controls, and other new innovations incorporated in the Edsel and the engineering study required to produce the automobile. (See page 69.)

Rambling . . .

THROUGH THE SECTIONS

SEMINAR of Missile Ground Equipment and Propulsion Systems was held December 2 and 3, 1957, at the **SOUTHERN CALIFORNIA SECTION.** Seminar chairman and moderator was A. L. Klein, engineering design consultant, Douglas Aircraft Co., Inc., and professor of Aeronautics, California Institute of Technology. Speakers of the first day's session on Missile Ground Equipment were T. W. Stephens, assistant chief, Missiles Ground Equipment Section, Douglas Aircraft Co., Inc., and Daniel T. Sigley, chief engineer, Guided Missile Division, Firestone Tire and Rubber Co.

Stephens' paper, entitled, "Nike Launching and Handling Equipment Design Objectives," included a discussion of the general problems in the use of Ajax launching equipment, and movies showing some aspects of the Nike-Ajax system and the Nike-Hercules system. Sigley's presentation was entitled "The Corporal Servicing and Handling Vehicles," and also included a movie.

Second day sessions were on Missile Propulsion Systems and included Floyd Twight, supervisor of program analysis, Rocketdyne Division, North American Aviation, Inc., and R. B. Canright, Missiles Powerplant Section, Douglas Aircraft Co., Inc. Presentations were entitled, "Applications of Liquid Oxygen Handling Techniques to Rocket Engine Testing," by Twight; and "Chemical Lessons Learned from the Nike-Ajax Development," by Canright. The latter paper included discussion of some of the problems with the solid propellant booster and the liquid sustainer rockets of the Nike-Ajax.

Below appear chairman and speakers of the December 2 meeting, Speaker T. W. Stephens, left, Chairman A. L. Klein, middle, and Speaker D. T. Sigley, right.



SEVEN ENGINEERS from Pacific Coast oil companies participated in a fuels and lubricants panel discussion at the November 8, 1957, meeting of the **NORTHWEST SECTION.** Presiding over the meeting was E. J. Wood of Shell Oil Co., and Section vice-chairman for fuels and lubricants.

Engineers on the panel included J. N. Plantfeber, Shell Oil Co.; Max Epps, General Petroleum Corp.; I. M. Harlow, Tidewater Oil Co.; B. Y. McCarty, The Texas Co.; Frank Fisher, Union Oil Co. of California; E. C. Rawlings, Standard Oil Co. of California; E. H. Whitney, Richfield Oil Corp.

Questions from the floor ranged from: "Where are we going in the octane

continued on page 110

SAE

ALBERTA

February 17 . . . Jack Harper, engineer, Ford Motor Co. "New Edsel Car Design." Royal Hotel, Second Street West and Eighth Avenue, Calgary, Alberta. Dinner 7:30 p.m. Meeting 8:30 p.m.

ATLANTA

March 13 . . . Gregory Flynn, Jr., head of research staff, Mechanical Development Department, General Motors Corp. "The Free Piston Engine." The Hellenic Center, 2124 Cheshire Bridge Road, N.E. Dinner 7:00 p.m. Meeting 8:00 p.m.

BALTIMORE

February 13 . . . J. S. Pasman, head of the Gas Turbines Section, U. S. Naval Engineering Experiment Station. "Gas Turbines in Naval Service." 6 West Fayette St., Baltimore. Dinner 7:00 p.m. Meeting 8:00 p.m.

BRITISH COLUMBIA

February 17 . . . E. J. Barth, chief engineer, Dana Corp. "Lightweight, Short Length, 12-speed Transmissions." Hotel Georgia, Vancouver.

BUFFALO

February 18 . . . "Small Economy Car." General Motors Training Center, Buffalo. Special Guest: 1958 SAE President William K. Creson.

CANADIAN

February 19 . . . William K. Creson, 1958 SAE President. "Steering of Modern Automotive Vehicles."

CENTRAL ILLINOIS

February 24 . . . Tour of Borg-Warner Corp. plant. Decatur, Ill.

SECTION MEETINGS

CHICAGO

March 11 . . . Joint session with ASLE. Speaker to be announced. "Fuels and Lubricants." Hotel Knickerbocker, Chicago. All-day session. Dinner 6:45 p.m. Special Feature: Social half-hour before dinner. 6:15 p.m.

CINCINNATI

February 24 . . . Lt.-Gen. Francis Griswald, vice commander SAC, U. S. Air Force. "The Roll of the SAC in the Defense of the Country." Cincinnati Club. Dinner 6:30 p.m. Meeting 8:00 p.m.

DETROIT

February 15 . . . Ladies' Night—Dinner Dance. Statler Hotel, Detroit. 6:30 p.m. to 12:00 Midnight. Price: $10.00 per plate. Open to SAE Members and Applicants only.

February 17 . . . John B. Nichols, Hiller Helicopters, Inc. "One-Man Vertical Take-Off Aircraft."—W. W. Shaver, Corning Glass Works. "Glass as a Structural Material."—D. J. Davis, Ford Motor Company. "Cold Working of Metals." Rackham Memorial Building, 100 Farnsworth, Detroit. Dinner 6:30 p.m. $3.25 per plate. Meeting 8:00 p.m. Dinner Speaker: Dr. H. K. Newburn, president, The Educational Television & Radio Center.

February 25 . . . Student Activity Meeting. Ford Motor Company Research Center, Dearborn. Tour and Dinner. Price: $1.75 per plate. Open to SAE Enrolled Students only.

INDIANA

February 20 . . . Von D. Palimas, engineer in charge—structures and suspensions, General Motors Engineering Staff, GM Technical Center, GMC. "Air Suspension." Indianapolis Naval Armory, Indianapolis. Dinner 7:00 p.m. Meeting 8:00 p.m. Special Feature: Panel discussion. Representatives of Firestone and U. S. Rubber Co. Also, film on Development of Air Suspension System.

KANSAS CITY

February 20 . . . John Coffin, resident engineer, Chevrolet Motor Co. "Sports Car Meeting." K. C. Sports Car Club invited. World War II Memorial Bldg., Linwood and Paseo. Dinner 7:00 p.m. Meeting 8:00 p.m.

METROPOLITAN

February 27 . . . W. Tauss, Grey Rock Div., Raybestos-Manhattan, Inc. "New Development in Brakes." Henry Hudson Hotel, 57th Street and 9th Avenue, New York. Meeting 7:45 p.m.

MID-CONTINENT

March 7 . . . Talk on "Free Piston Engine." Cushing, Okla. Social Hour 7:00 p.m. Meeting 8:00 p.m.

MID-MICHIGAN

March 3 . . . Nevin L. Bean, Ford Motor Co. "Status of Russian Technology." Zehnder's Restaurant, Frankenmuth, Mich. Cocktails 6:30 p.m. Dinner 7:00 p.m. Meeting 8:00 p.m. Coffee Speaker: 1958 SAE President, William K. Creson.

MILWAUKEE

March 7 . . . 1958 SAE President, William K. Creson will be a special guest at this meeting. Program to be announced.

MONTREAL

February 17 . . . 1958 SAE President, William K. Creson. "Steering of Modern Automotive Vehicles." Sheraton Mount-Royal Hotel, Montreal. Dinner 7:00 p.m. Meeting 7:45 p.m.

NORTHERN CALIFORNIA

February 26 . . . A. L. London, professor of engineering, Stanford University, Stanford. Student Meeting—"Free Piston Engines." University of California Faculty Club, Berkeley. Dinner 6:30 p.m. Meeting 8:00 p.m. Special Feature: A Student Economy Run.

OREGON

February 13 . . . E. J. Barth, chief engineer, Dana Corp. "12-Speed Transmission." Imperial Hotel, Portland. Dinner 7:00 p.m. Meeting 8:00 p.m.

PHILADELPHIA

February 12 . . . J. R. Rowell, Supervisor, Cummins Engine Co. "Effect of Dirt on Engines." Engineers Club of Philadelphia. Dinner 6:30 p.m. Meeting 7:45 p.m. Special Feature: President's Night—Coffee Speaker: 1958 SAE President, William K. Creson.

March 12 . . . Gordon H. Maxwell, director of maintenance, The Hertz Corp. "Operating Experience with Automatic Transmissions." Engineers Club of Philadelphia. Dinner 6:30 p.m. Meeting 7:45 p.m.

PITTSBURGH

February 25 . . . G. W. Jackson, staff engineer, Delco Products Division, GMC. "The General Motors Air Suspension." Mellon Institute, Pittsburgh. Dinner 6:00 p.m. Meeting 8:00 p.m.

ST. LOUIS

February 11 . . . N. A. Hunstad, General Motors Research Staff. "Automatic Transmission Fluid." Congress Hotel, St. Louis. Dinner 7:00 p.m. Meeting 8:00 p.m.

SALT LAKE CITY

February 17 . . . E. J. Barth, chief engineer, Dana Corp. "12-Speed Transmission." Hotel Newhouse, Salt Lake City. Meeting 8:00 p.m.

SOUTHERN NEW ENGLAND

March 5 . . . Dr. J. C. Hamaker, Jr., manager of research, Vanadium Alloys Steel Co. "High Strength Steels." Farmington Country Club, Farmington. Dinner 6:45 p.m. Meeting 8:00 p.m.

SPOKANE-INTERMOUNTAIN

February 19 . . . E. J. Barth, chief engineer, Dana Corp. "12-Speed Transmission." Desert Caravan Inn, Spokane. Dinner 6:30.

TEXAS GULF COAST

February 28 . . . Richard E. Wainerdi, assistant professor, Texas A & M College. "Nuclear Research in Fuels and Lubricants, Friction and Wear, Metal Analysis and Heat Transfer." Texas A & M. Dinner 7:30 p.m. Meeting 8:15 p.m. Special Feature: Atomic Reactor Plant Facilities Tour on the Campus.

TWIN CITY

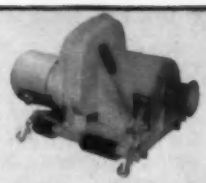
February 12 . . . Neil Blume, chief enginner, Edsel Division, Ford Motor Co. "Engineering the Edsel." Hasty Tasty Restaurant, 1433 W. Lake St., Minneapolis. Dinner 6:45 p.m. Meeting 8:00 p.m.

WASHINGTON

February 18 . . . Martyn V. Clark, Civil Aeronautic Board. "Accident Investigation, Procedures and Techniques Used in Aircraft Accidents." Occidental Restaurant, Washington. Dinner 7:00 p.m. Meeting 8:00 p.m.

WILLIAMSPORT

March 3 . . . Moose Club Auditorium, Williamsport. Dinner 6:45 p.m. Meeting 8:00 p.m.



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AIR CARGO EQUIPMENT CO.
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Our use of LUBRIPLATE Lubricants exclusively, followed the "torture testing" of our Bulldog Cargo Winch at an Air Force test center. The 196 pound winch, lubricated with LUBRIPLATE, was operated under a six ton load in environments of extreme heat, cold, salt, humidity, dust, altitude, explosive vapor and pressure. Now, our unconditional guarantee is valid only if the LUBRIPLATE Lubricants, factory sealed in our winches, are not replaced by other lubricants.

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Rambling . . .

THROUGH THE SECTIONS

continued

race?"—which was answered, to "What about boron fuels?"—which was not answered because it was considered to cover classified information.

On octane trends, Epps responded that octane numbers are rising about one point a year; on the Pacific Coast motorists may expect to be able to obtain gasoline rated at 98–99 octane, based on Research rating methods.

"There is a lot of interest," Epps said, "in returning to the old Motor method of rating fuels. There is difficulty in determining road ratings of engines using the Research method. The trend is to improve road ratings of fuels."

Answering the question, "What is the best operating temperature of oils in an automobile crankcase?" Plantfeber said that the petroleum engineer would like to have the temperature high enough to boil off water or condensed water vapor. Additives perform better at higher temperatures, too . . . temperatures of 160–180 F are to be preferred. Engine speed will determine oil temperature levels more than road speed, he added.

"Most additive oils on the market today are compatible," Harlow said. "However, if you have a badly oxidized oil in your crankcase, fresh oil might precipitate out the heavy sludge in the filter."

Plantfeber warned that immediate take-off after starting a cold engine can ruin the engine. All of the engineers agreed that adequate lubrication with heavy-duty oils will do more to insure long engine life with a new engine than use of oils that permit what is referred to as "quick break-in."

It should be remembered that the break-in period is a wear period, too, the engineers agreed. Better practice is to spend the few cents more it may cost, in terms of higher oil consumption, during the initial "wear-in" and thereby reduce wear on cylinder walls, bearings, and rings. "A few dollars more on oil in a new engine may extend engine life 10,000–20,000 miles," one engineer said. All agreed.

On the subject of greases, McCarty warned against overpacking bearings. "Overpacking increases friction," he said, "and heats up the oil."

To prevent sludge the engineers said: be sure your thermostat is working. Keep the crankcase breather clean, and drain oil more frequently if you are doing city stop-and-go driving. To another question, it was agreed that the recommendation that oil be changed every 1000 miles still stands.

"TRENDS IN TRUCK TRANSMISSIONS," presented by William S. Coleman, assistant chassis engineer of White Motor Co., was the topic of **MOHAWK-HUDSON SECTION'S** December 10, 1957, meeting.

Coleman told engineers of current happenings in the truck transmission field and the future of them. He said, "th etruck driver is sure to end up with an easier job, and the available engine horsepower will be more fully utilized.

In exchange for these features, we will undoubtedly experience some growing pains and at the same time become more educated in manufacturing and maintaining more complex transmissions."



Right are Section Chairman P. E. Kezer, left, Speaker W. S. Coleman, middle, and Section vice-chairman in charge of the meeting, M. J. Severino, right.

MORE THAN



10,000,000

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WERE BUILT INTO 1957 MODEL AUTOMOBILES!

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That's right—over *ten million tapered* roller bearings were supplied by HYATT during the 1957 model year. Pretty convincing proof that America's recognized leader in the cylindrical bearing field is also a big and growing source for *tapered* roller bearings!

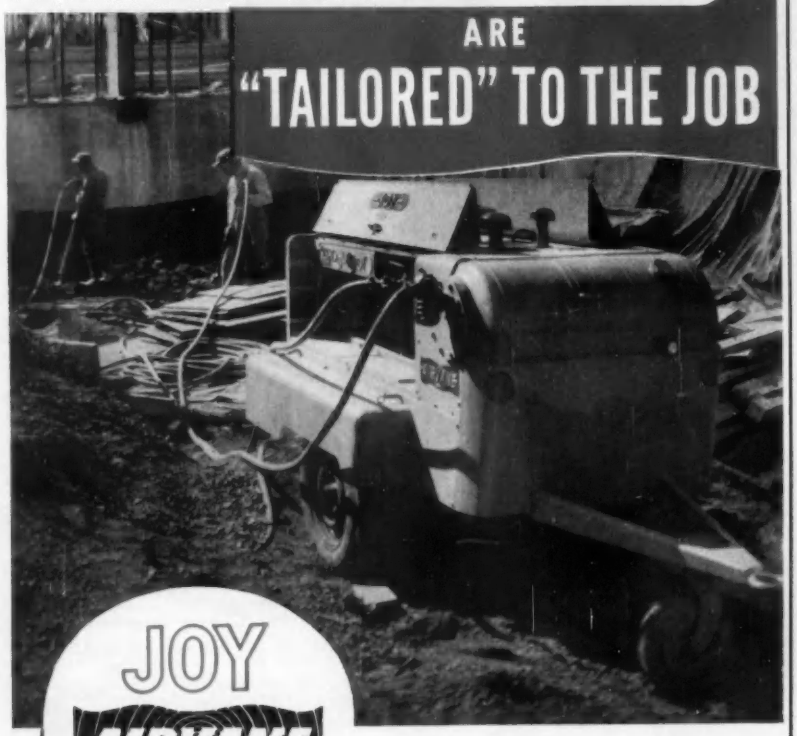
No facilities in the industry surpass HYATT'S multi-million dollar, fully integrated production lines which are turning out tapered roller bearings with greater uniformity than ever before achieved in quantity production. You'll find *things run smoother* when they roll on HYATT bearings! Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.; Detroit; Pittsburgh; Chicago; and Oakland, California.

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AIRVANE

CONTINENTAL MOTORS · Powerful as the Nation · AMERICA'S STANDARD ®

Product of experience that has been turning out reliable machinery for more than 100 years, this Joy Model RP-125G Airvane Rotary Portable Compressor has as its "heart" a Continental Red Seal, engineered to the exacting requirements of compressor use. Continental ruggedness and rightness of design are helping to build prestige for more and more of the leading builders of specialized power equipment.

ANY MACHINE IS BETTER
WITH DEPENDABLE RED SEAL POWER.

•

WORLD'S LEADING INDEPENDENT MANUFACTURER OF INTERNAL COMBUSTION ENGINES, CONTINENTAL MOTORS OPERATES PLANTS IN ATLANTA, DALLAS, DETROIT, MILWAUKEE, MUSKEGON, AND TOLEDO, AND IN ST. THOMAS, ONT., PRODUCING AIR-COOLED AND LIQUID-COOLED ENGINES FOR USE ON LAND, AT SEA AND IN THE AIR.

CONTINENTAL ENGINES ARE BACKED BY FACTORY-APPROVED SERVICE AND GENUINE RED SEAL PARTS ALL OVER THE WORLD

•

Continental Motors Corporation

MUSKEGON • MICHIGAN

About SAE Members

Continued from page 103

gineer with the Douglas Aircraft Co. in Santa Monica, Calif. In his work he conducts and assists with research and development rocket test firings on a missile project.

HARLOW H. CURTICE, president of General Motors Corp. and chairman of the President's Committee for Traffic Safety, recently addressed the opening session of the Public Officials Traffic Safety Conference, sponsored by the Committee. Curtice stated that traffic accident problems must be solved by "sound and aggressive leadership" on the part of public officials. The Committee is responsible for stimulating leadership and conducting a broad program of public information and organizational activities.

L. E. GRUBB has been appointed an assistant vice-president of the International Nickel Co., Inc. He has been general superintendent of the Huntington, W. Va., works of the company since 1953 and has been associated with International Nickel since 1934. Grubb will be in charge of labor relations at all U.S. plants and will transfer to the company's New York office.

WILLARD W. BROWN, president of Clevite Corp.'s Cleveland Graphite Bronze Division, has been elected a Clevite director. Brown became president of Cleveland Graphite in August, 1955; prior to that he had served as vice-president—marketing, and as assistant to the president. He joined the organization in 1951 as mobilization director.

W. C. SCHUMACHER has been elected an executive vice-president and member of the board of directors of International Harvester Co., Chicago. He has been with the company since 1917 and formerly served as a vice-president of the company and executive head of its motor truck division.

CHARLES H. MORSE, JR., formerly western regional manager, Railroad Division, Fairbanks, Morse and Co., is now president of Morse Metals Corp., Chicago.

J. G. STAFFORD has become the partner of Ralph Shrader, Inc., of Whittier, Calif., as director of sales and service. Previously he has been associated with the Supertest Petroleum Corp. in London as manager, technical service.

ARTHUR N. HEATH, formerly chief chemist at Electrofilm, Inc., North Hollywood, Calif., is now in technical sales for the Electrical Division of Furane Plastics, Inc., Los Angeles.

you can meet any lubrication specification if you

BLEND WITH ENJAY PARATONE®

(VISCOSITY-INDEX IMPROVERS)

Base stocks blended with Enjay Paratone can be compounded into lubricants combining cold-weather quick starting properties with high temperature, low consumption characteristics. These lubricants are *all-season* oils, featuring improved gas mileage. More and more refiners and blenders are relying exclusively on Paratone to produce the high "VI" required in these all-season oils.

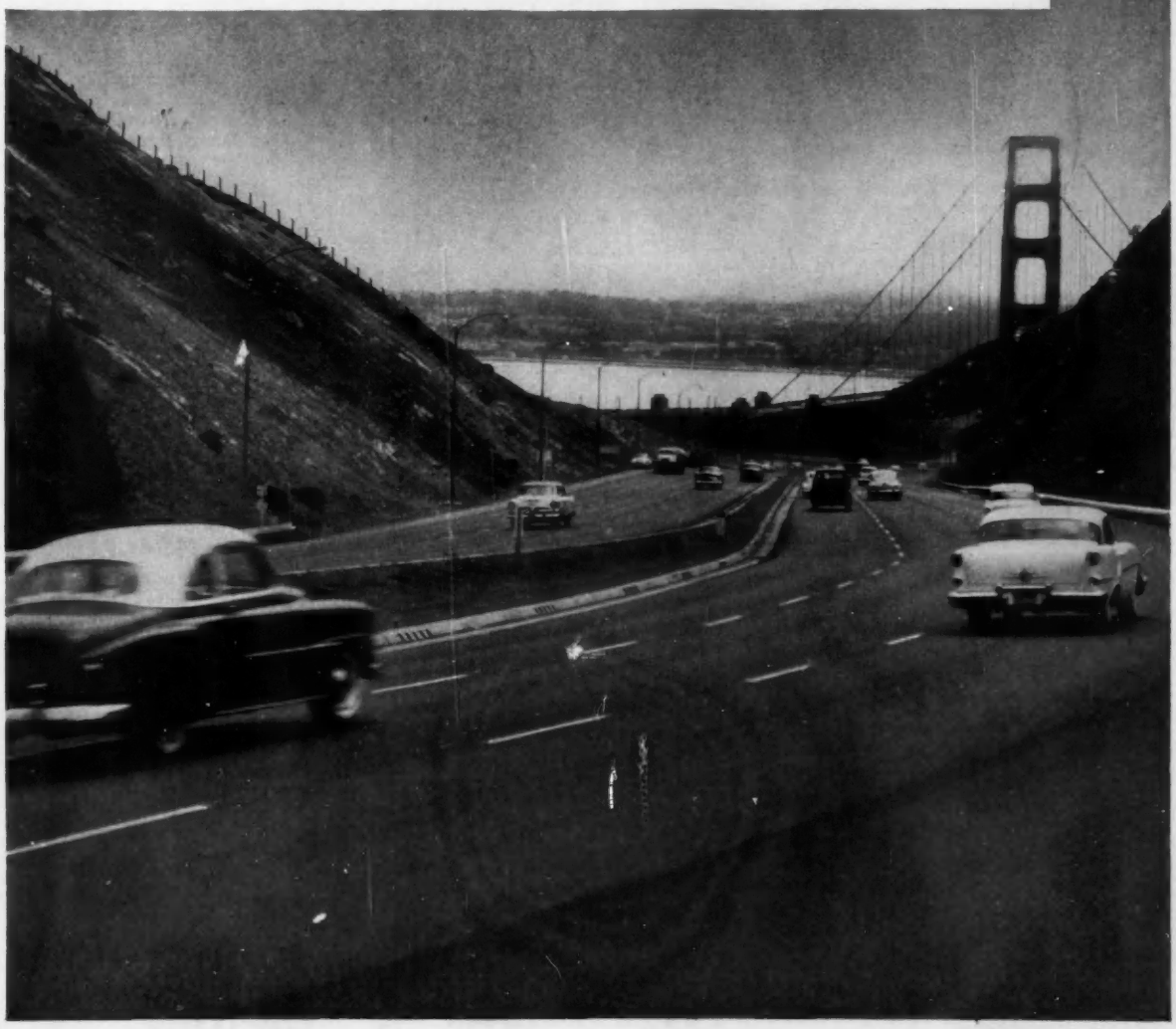
Through years of intensive research and development work with automotive manufacturers, Enjay has developed the only *complete line* of high quality additives (Paramins®) that can assure *maximum* performance characteristics. Why not let this experience and know-how work for *you*? Write, wire or phone the Enjay Company.

ENJAY

Pioneer in Petrochemicals

ENJAY COMPANY, INC., 15 WEST 51st ST., NEW YORK 19, N. Y.

Akron • Boston • Chicago • Detroit • Los Angeles • New Orleans • Tulsa



NEW OAKITE CLEANERS
GIVE YOU MORE FOR YOUR
PAINT-PREPARATION DOLLAR

Here are 4 ways to end pre-paint metal-cleaning troubles

Does your trouble chart show that you need better cleaners, strippers or surface conditioners?

- ☐ Cleaning solution foams excessively in spray washing machine. See 1 below.
- ☐ Streaky discolorations or powdery residues cling to surface of steel parts being stripped for repainting. See 2.
- ☐ Zinc phosphating process too difficult to control... Iron phosphating process doesn't show good results in salt spray tests. See 3.
- ☐ Too many operations—cleaning, pickling, neutralizing, etc.—are needed to prepare steel that does not require phosphating before painting. See 4.

Here are brief descriptions of new Oakite materials designed to end these particular troubles:

1. For a spray washing solution that does not foam at high pressure, try Oakite Composition No. 161. Does not attack aluminum.
2. For stripping pigmented paint, phosphate coatings and undercoat rust *in one operation*, try Oakite Rustripper.
3. For a zinc phosphating process that is truly easy to control, try new Oakite CrysCoat SW . . . For salt spray results far beyond the capacity of ordinary phosphating processes, try new Oakite CrysCoat No. 89.
4. For *one-operation* removal of rust, heat scale, welding residues and light soil together with good preparation for painting, try Oakite Compound No. 131. Inhibited against attack on steel.

FREE Check the coupon and we will send you free booklets or bulletins with full information on new Oakite cleaners.



OAKITE

OAKITE PRODUCTS, INC.
38H Rector Street, New York 6, N. Y.

Send me free booklets or bulletins giving complete information on the new Oakite materials checked below:

☐ Oakite Composition No. 161
☐ Oakite Rustripper
☐ Oakite CrysCoat SW
☐ Oakite CrysCoat No. 89
☐ Oakite Compound No. 131

NAME_____

COMPANY_____

ADDRESS_____

continued from page 92

they are intended. . . . We don't care about streamlined, modern appearance in utility-type vehicles." A private carrier man complained about "over-styling of truck bodies for city work. . . . We can't affix signs to sculptured bodies . . . and they're too hard and costly to repair.

Another fleet man said "the low silhouette has been instrumental in increasing accidents. . . . And a for-hire common carrier man added: "Over-the-road operators don't care about style either."

How to Prevent Carburetor Icing

Based on paper by

I. T. ROSENLUND
E. I. du Pont de Nemours & Co.

THREE ways to prevent carburetor icing are:

- Add more carburetor heat.
- Add surface active agents to the gasoline. These will coat the carburetor and prevent ice from sticking.
- Add compounds which lower the temperature of the water in the fuel-air mixture.

In the latter method the compounds must vaporize to burn harmlessly in the engine and yet be nonvolatile enough to remain liquid and combine with the water to depress its freezing point.

To Order Paper No. 244 . . . on which this article is based, see p. 5.

Fuel Additives Need Engine Life Test O.K.

Based on talk by

ROBERT V. KERLEY
Ethyl Corp.

(Presented before SAE Mid-Continent Section)

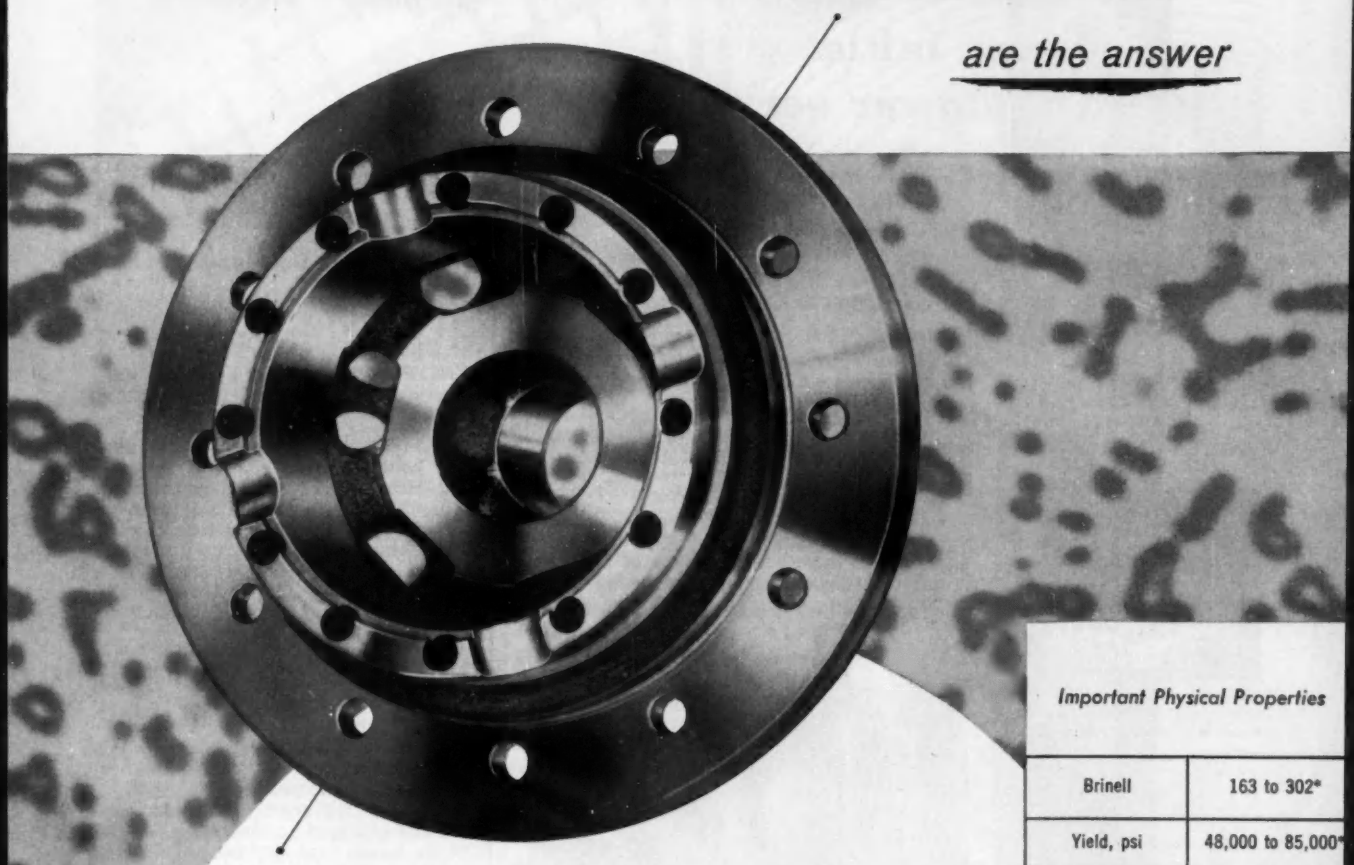
THE development of a successful fuel additive requires considerable effort, a large share of which must be expended on the effect of the additive on engine durability. Of seven experimental additives tested in a fleet of passenger cars of one make operated under severe-duty conditions, four additives decreased exhaust valve life while three increased it by 25–50%. In another make of passenger car operated under the same severe conditions, none of the additives affected valve life. As little as 1 gal of addi-

is your problem

machinability?

NATIONAL HTM CASTINGS

are the answer



There are many reasons for specifying HTM (Pearlitic Malleable) castings for your product. One is *machinability of 70-90 percent* (B1112 steel = 100).

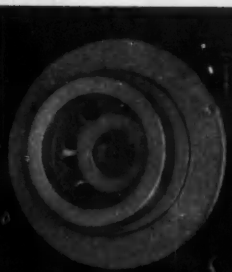
But there are many other equally valid reasons. High ultimate strength . . . extreme wear resistance under heavy loads and high speeds . . . non-seizing qualities . . . air or liquid quenching . . . ability to be smooth-finished.

So when you're looking over the materials field, don't overlook the advantages of HTM castings. For HTM metal can be cast by either the shell mold, CO_2, or green sand methods. This means production costs tumble . . . performance and saleability of your product go up.

Important Physical Properties

Brinell	163 to 302*
Yield, psi	48,000 to 85,000*
Ultimate, psi	70,000 to 110,000
Elongation, %	7 to 2*

**Depending upon grade*



NATIONAL MALLEABLE and STEEL CASTINGS COMPANY

Established 1868 — *Cleveland 6, Ohio*

AA-6632

The nation's largest independent producer of malleable and pearlitic malleable

tive in 50,000 gal of fuel may reduce exhaust valve life to half of normal. Increased amounts of the same additive may actually increase exhaust valve life by more than half.

Consideration of all of these factors makes it necessary to conduct thousands of hours of dynamometer tests and millions of miles of road tests in a wide variety of engines before a fuel additive can be marketed with assurance that its overall effects will benefit the ultimate user.

The results of a survey of spark-plug fouling in 193 late-model passenger cars of four popular makes showed that approximately one-third of the spark-plug sets were fouled sufficiently to cause at least 20% decrease in vehicle performance. While the vehicle models and number of cars involved are limited and do not completely represent the car population nor types of service, the survey did provide a sample of the three main price classes of cars. The results indicate that a considerable amount of spark-plug fouling exists in vehicles driven in city and city-suburban service. Recognition of spark-plug fouling by car owners varied with car make.

Changes in antiknock compound and fuel-sulfur concentration as well as changes in fuel base stock composition affect spark-plug fouling. The commercial formulation of a finished fuel, however, is dictated not primarily by spark-plug fouling, but by other important considerations, such as fuel octane number. The large effects of changes in the composition of the fuel base stock indicate an important area for future research. Phosphorus fuel additives offer a commercial solution by at least doubling the time to spark-plug failure.



Tests Reveal Performance Of Ceramic Cutting Tools

Based on paper presented as part of a panel by

J. N. WILLITS

Ryan Aeronautical Co.

TESTS on the machining of high-temperature alloys with ceramic cutting tools reveal:

1. The workpiece, machine, and tool holder must be vibration free.
2. Heavy scaled, or out-of-round scaled surfaces are not practical for ceramic applications.
3. Ceramics cannot be used successfully on interrupted cuts. (This is not to be confused with intermittent cuts with no impact or shock involved.)

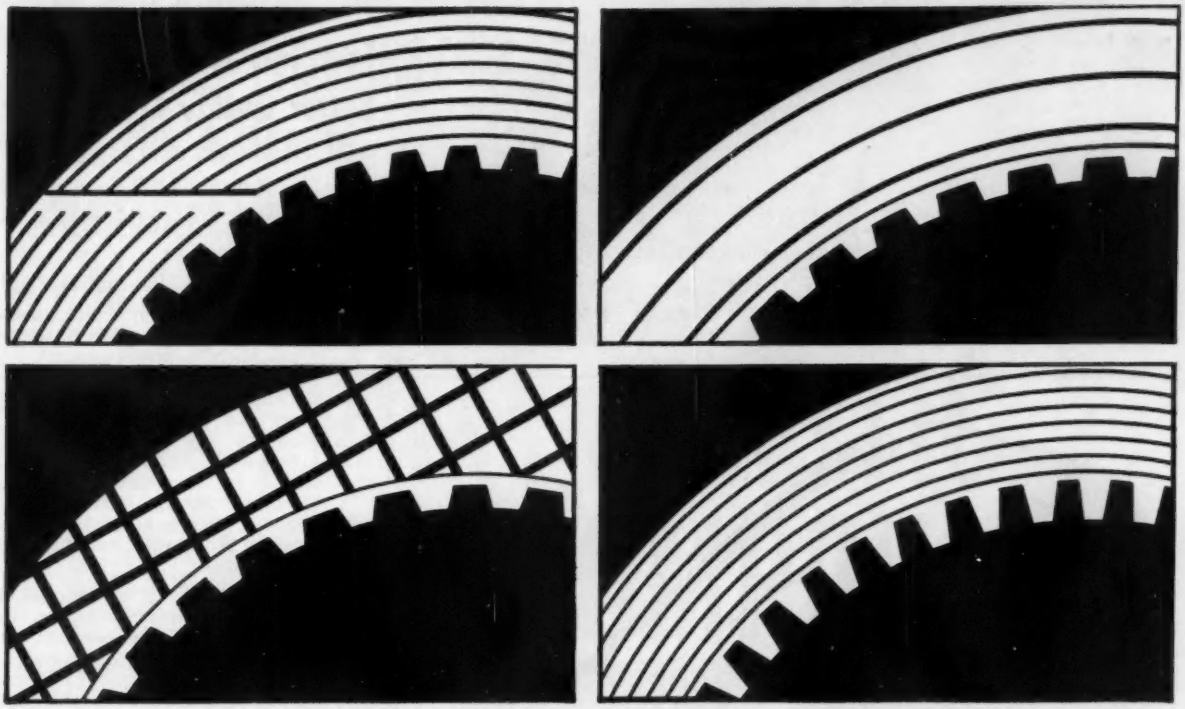
For initial test purposes, one production part was selected and a billet of type 347 stainless steel obtained. The production part was a case weldment fabricated from type 410 stainless steel sheet stock. In facing the flange, ceramic tool bits performed fairly well, but results fell short of carbide tools. Results obtained in machining the ID of the bands were very poor.

One triangular carbide insert with 0.030 in. radius produces 6 to 9 parts per insert, or 1 to 1½ parts per cutting edge.

With the ceramic inserts used, 2 to 3 cutting edges were required to produce one part. The presence of a weld nugget in the seam welded bands presented a condition comparable to an interrupted cut. The character of cutting edge deterioration ranged from the point chipping, to complete fracture of the insert—depending on the severity of the shock load imposed.

In the machining of the type 347 stainless steel, results obtained were

ANOTHER EXAMPLE OF HOW CONTINUING RESEARCH KEEPS R/M FIRST IN FRICTION



How R/M grooves friction material to give you better performance at lower cost

Putting grooves in friction material is a relatively simple operation that can produce some highly complex results.

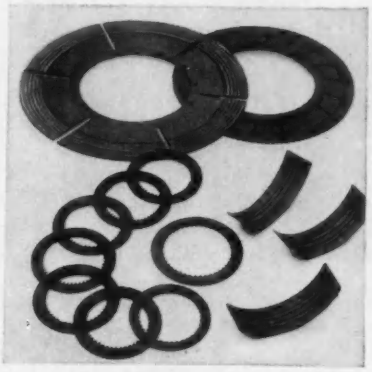
Friction material—clutch facings, automatic transmission discs, brake linings—may be grooved for a variety of different reasons: to dissipate heat, reduce wear, improve engagement, prevent sticking, increase friction, direct or control the flow of oil.

Different groove patterns in different types of friction materials give widely different performance characteristics. Yet the *same* groove patterns in different type materials may also give different results. Consequently, choosing the best groove pattern for a friction application can be a very hard—and important—job.

Unlike other manufacturers, R/M works with *all* types of friction materials. So you can be sure of a completely unbiased recommendation when you consult an R/M engineer. Constantly testing, exploring, developing in advance of the day's needs, we are constantly finding new and profitable answers to friction problems. We may have the answers to those you are facing now. And with our sales engineers in the field, we can have a man at your desk on any problem within 24 hours.

Whatever your requirements, whatever your application, whenever you think of friction, think first of R/M.

Write now for free catalog. It is loaded with practical design and engineering data on all R/M friction materials.



Brake linings, clutch facings, and automatic transmission discs showing some of the different groove patterns for better friction performance.

R/M FIRST IN FRICTION

RAYBESTOS-MANHATTAN, INC.

EQUIPMENT SALES DIVISION: Bridgeport, Conn. • Chicago 31 • Cleveland 16 • Detroit 2 • Los Angeles 58

RAYBESTOS-MANHATTAN, INC., Brake Linings • Brake Blocks • Clutch Facings • Sintered Metal Products Industrial Adhesives • Mechanical Packings • Asbestos Textiles • Industrial Rubber • Rubber Covered Equipment • Engineered Plastics • Abrasive and Diamond Wheels • Laundry Pads and Covers • Bowling Balls

more favorable. For this series of tests a new lathe was used with a speed range up to 2000 rpm. And since the spindle, carriage, and other moving parts were tight, optimum machining conditions prevailed.

In truing up the billet, the ceramic inserts failed rapidly due to the part being out-of-round and the surface being work-hardened from the rolling operations. The work-hardened chip flow notched the insert rapidly. This condition, in conjunction with the varying load imposed on the insert due to the constant reentering of the workpiece by the cutting edge, and the rapid abrading of the cutting edge contributed to the short tool life. Test results indicate that square inserts performed best from a tool-life standpoint and that tool life decreases as the depth of cut is increased. Also, negative rake ceramic throw-away inserts can be successfully used for finishing cuts at higher surface speeds than with carbides, with comparable tool life.

To Order SP No. 321 . . .
on which this article is based, see p. 5



METICULOUS CONTROLS

every hour, every heat, every day

Small ferrous alloy castings, electrically melted, and produced in high volume, have been our business since 1946.

But, in every instance, customers' needs have been unusual—involving controls to such exacting specifications that we could not rely upon ordinary foundry practices. At every critical point in the process, our own "technical policemen" are on duty every operating hour.

These manufacturing controls supplement our laboratory practice, and they make it possible to maintain the exacting customer specifications in high volume.

Suppliers of critical component castings to the automotive, aircraft, hydraulic, and special machine industries since 1946.

ENGINEERING CASTINGS, INC.

MARSHALL, MICHIGAN

Four Tips for Getting Better Quality Control

Based on secretary's report by

A. E. JAKEL

Quality Control Consultant

QUALITY control will be improved by:

1. Getting across to production people the fact that quality of product is their responsibility.
2. Providing for quality investigations and studies during processing.
3. Planning the inspection work; providing definite instructions, similar to job instruction sheets, for manufacturing operations.
4. Tracing the responsibility for rejections back to the manufacturing supervisor.

Other members serving on the panel which developed the information in this article were: **R. L. Hermann,** Power Products Corp.; **L. K. Vollenweider,** Deere and Co.; **A. J. Spelich,** Waukesha Motor Co.; **E. Schmit,** Allis-Chalmers Mfg. Co.; and **J. R. Parker,** A. O. Smith Corp.

To Order SP No. 320 . . .
on which this article is based, see p. 5

Costs Cut with Self-Tapping Inserts

Based on secretary's report by

J. G. BOEHM

Briggs and Stratton Corp.

SELF-tapping inserts are a simple, low-cost solution to threaded holes in die castings. They can have the following performance and production advantages:

1. Can stand vibration without loosening.
2. Provide a strong, hard, accurate (Class 3 or better) internal thread.
3. Provide high locking torque with low driving torque.
4. Can be driven in cored holes.
5. Automation driving of insert is possible.
6. Eliminate thread inspection.
7. Simplify field service.

Members of the panel which develop the information in this article are: **F. J. Stuckert,** chairman, Briggs and Stratton Corp.; **J. G. Boehm,** secretary, Briggs and Stratton Corp.; **Frank**

(Continued on page 123)

New Economy and Speed in Tooling Production for the Airframe Manufacturer with POLYTOOL



Photos courtesy of Arrowsmith Plastic Tooling, Inc., Los Angeles, Calif.

RCI EPOXY PLASTIC TOOLING COMPOUNDS



In the photos above you see a completed plastic stretch die and the laminating build-up stage in its fabrication.

This plastic stretch die has excellent dimensional stability. It is lightweight and was produced fast at low cost.

Reichhold, a basic manufacturer of resins, offers you a full line of epoxy plastic compounds for tool production.

POLYTOOL 2501 (white finish) and **2551** (metallic) are epoxy plastic tooling compounds for casting and laminating applications.

POLYTOOL 2502 (white finish) and **2552** (metallic) are epoxy plastic tooling compounds for gel coat application.

Reichhold supplies low irritation **POLYTOOL HARDENERS** for varying the gel time of these compounds. Reichhold also furnishes POLYTOOL compounds for a 3-component system with which you can vary working properties to meet specific requirements.

Why not investigate the **RCI POLYTOOL** line of plastic tooling materials? It includes not only epoxy, but also polyester, phenolic and polyurethane resin systems. RCI offers you outstanding quality control of these materials.

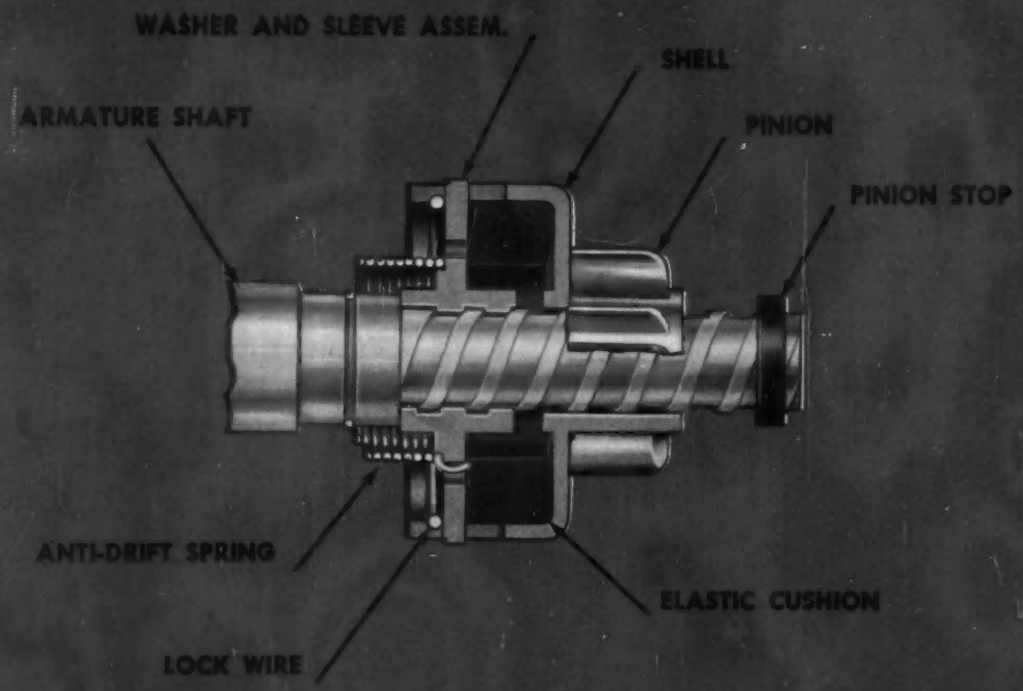
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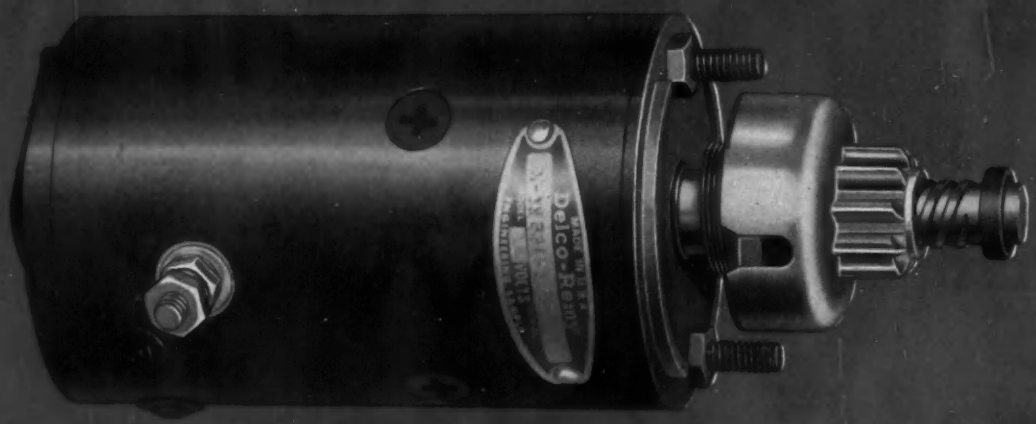
Synthetic Resins • Chemical Colors • Industrial Adhesives • Phenol
Hydrochloric Acid • Formaldehyde • Glycerine • Phthalic Anhydride
Maleic Anhydride • Sebacic Acid • Ortho-Phenylphenol • Sodium Sulfite
Pentaerythritol • Pentachlorophenol • Sodium Pentachlorophenol
Sulfuric Acid • Methanol

REICHHOLD CHEMICALS, INC.,
RCI BUILDING, WHITE PLAINS, N.Y.

Creative Chemistry... Your Partner in Progress

PROGRESSIVE ENGINEERING MAKES THE DIFFERENCE





TYPICAL CRANKING MOTOR WITH NEW HIGH-TORQUE DRIVE

DELCO-REMY PRESENTS A NEW HIGH-TORQUE CRANKING MOTOR DRIVE FOR HUSKIER 1958 OUTBOARDS AND OTHER APPLICATIONS

Delco-Remy's newly developed high-ratio cranking motor drive provides ample starting torque for sixty horsepower 1958 model outboards without increase in cranking motor size or the use of reduction gears. Where inches and ounces count, this new, lighter, more compact mechanism allows design engineers vital latitude in engine development. The new unit eliminates bulky overlapping parts common to earlier inertia drives and permits the use of a smaller pinion which provides higher ratio cranking without increase in ring gear size, or the same ratio with a smaller ring gear. All parts of the new drive are light but rugged, and assembly or disassembly is quick and easy. Construction details are shown in the cross-section view on the opposite page.

Available now for original equipment applications, the new drive can be supplied on cranking motors suitable for engines up to 150 cubic-inch displacement. This new drive is yet another example of Delco-Remy leadership in electrical equipment "Wherever Wheels Turn or Propellers Spin." Manufacturers of engines and power equipment are invited to write directly to Delco-Remy for complete information and engineering assistance on the application of these units.

DELCO-REMY • DIVISION OF GENERAL MOTORS • ANDERSON, INDIANA

GM GENERAL MOTORS

GENERAL MOTORS LEADS THE WAY—STARTING WITH

Delco-Remy

ELECTRICAL SYSTEMS



"I ALWAYS HAVE AIR TO SPARE ...I've Got a MIDLAND Compressor!"

"A long grade like that's a cinch with a Midland Compressor working for you . . . Shucks, I always have plenty of air for any kind of emergency — long hills or the stop and go you get in city traffic. My Midland Compressor keeps my air tanks full *all* the time."

Truck operators everywhere are learning more about the merits of Midland Compressors from their drivers — and from their maintenance supervisors, too. Midland Compressors not only perform more efficiently and reliably — they're easier to maintain and generally operate for hundreds of thousands of miles without servicing.

Midland Compressors feature these big advantages:

Greatest Efficiency — Due to patented automatic inlet valves built into cylinder head.

Minimum Oil Consumption — Due to lack of high vacuum on suction stroke.

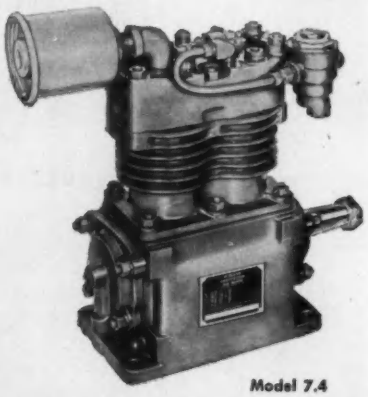
Cooler Operation — Because inlet valves let atmospheric air circulate through compressor when idling, practically eliminating carbon.

Integral Governor—Governor mounted on compressor simplifies installation.

Less Weight — A very important factor for today's operators.

Reduced Maintenance — Lack of compressor oil pumping greatly reduces maintenance due to elimination of oil and varnish deposits throughout the entire air brake system.

For complete details, see your nearest Midland dealer — or write the factory direct.



Model 7.4

M-R MIDLAND-ROSS CORP.

MIDLAND-ROSS CORPORATION

Executive Offices: Cleveland 1, Ohio

Formerly

THE MIDLAND STEEL PRODUCTS COMPANY

Cleveland • Detroit • Owosso, Michigan

And

J. O. ROSS ENGINEERING CORPORATION

New York City, N. Y.

Including John Waldron Corporation • Midwest Fulton Corporation • Ross Engineering of Canada, Limited Andrews & Goodrich, Incorporated

(Continued from page 118)

Ferguson, Outboard Marine and Mfg. Co.; **E. Mahlstedt,** Metal Thermit Corp.; and **Howard Schweppe,** consultant.

To Order SP No. 320... on which this article is based, see p. 5.

Process Grinds and Mills Electrolytically

Based on paper presented as part of a panel by

L. A. WILLIAMS
Anocut Engineering Co.

THE Anocut process provides accelerated etching and lapping of high-alloy materials.

A low-voltage high-current supply is connected to the grinding wheel, usually through the spindle, and to the workpiece such as to make the workpiece electrically positive. That is, the part being cut acts as the anode in the circuit.

By passing the electric current through an electrolytic solution to the workpiece, the bulk of the material is removed by electric current flow, and not by abrasion. This eliminates the problem of heat, tearing of metal does not occur, and wheel life is extended—in many cases to 10 or 15 times its former useful life.

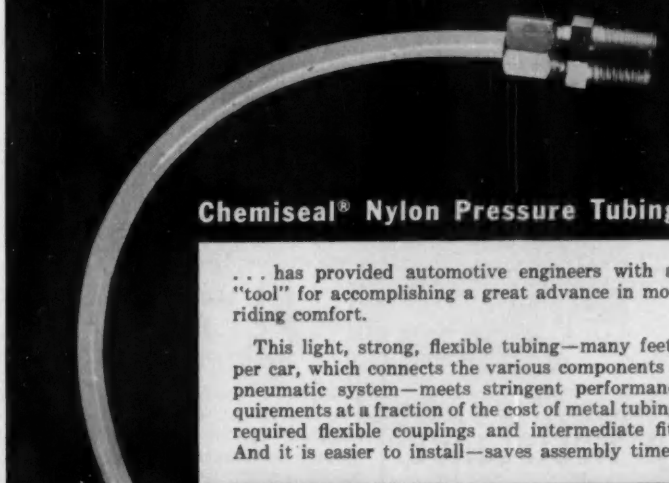
The removal rate of the process is almost independent of the hardness or toughness of the material, and depends primarily upon the electrochemical characteristics of the material and upon the area of the work which is available for working.

These characteristics make the Anocut process especially adaptable for three kinds of situations:

1. Hard materials.
2. High-strength materials.
3. Hard-to-machine materials. Many materials having reasonably high tensile strength but still not in the super-alloy class are troublesome to machine because of burrs at the edges and ends of the workpiece. The Anocut method does not produce burring, and, on many of these materials, the removal rate is as fast or faster than conventional grinding. This is particularly true on thin sections where conventional machining at high speed causes warpage and distortion which would be unacceptable.

There is a wide range of commonly used materials which are easily machined by conventional processes at fast rates. The Anocut process offers no advantage for these materials and may be considerably slower than the conventional processes. Cast iron and

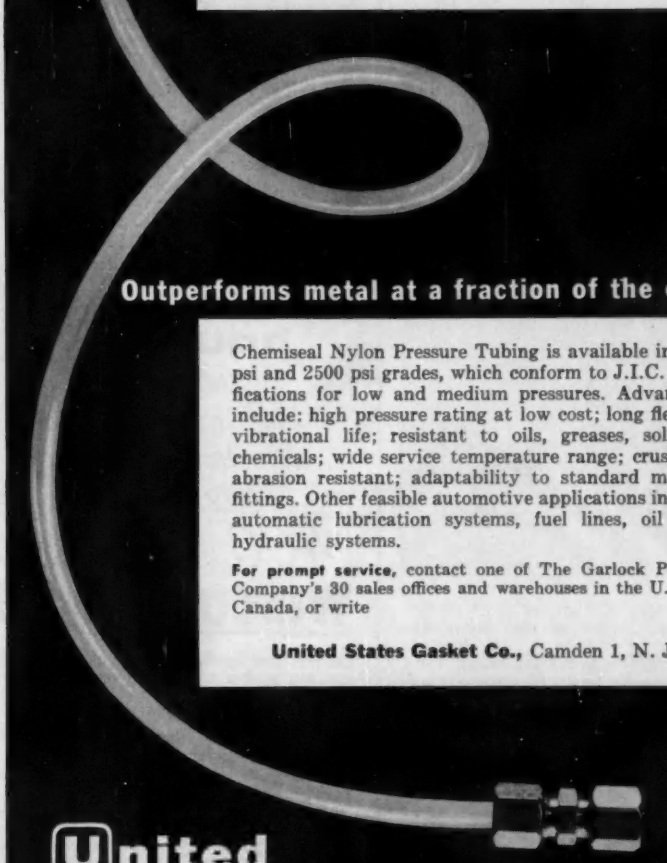
Original Equipment on the New Air Suspension



Chemiseal® Nylon Pressure Tubing

. . . has provided automotive engineers with a new "tool" for accomplishing a great advance in motorcar riding comfort.

This light, strong, flexible tubing—many feet of it per car, which connects the various components of the pneumatic system—meets stringent performance requirements at a fraction of the cost of metal tubing with required flexible couplings and intermediate fittings. And it is easier to install—saves assembly time.



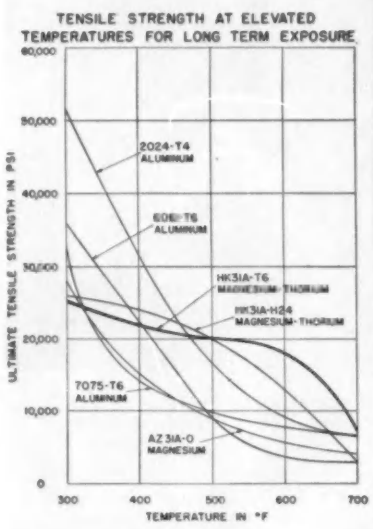
Outperforms metal at a fraction of the cost

Chemiseal Nylon Pressure Tubing is available in 1000 psi and 2500 psi grades, which conform to J.I.C. specifications for low and medium pressures. Advantages include: high pressure rating at low cost; long flex and vibrational life; resistant to oils, greases, solvents, chemicals; wide service temperature range; crush and abrasion resistant; adaptability to standard metallic fittings. Other feasible automotive applications include: automatic lubrication systems, fuel lines, oil lines, hydraulic systems.

For prompt service, contact one of The Garlock Packing Company's 30 sales offices and warehouses in the U.S. and Canada, or write

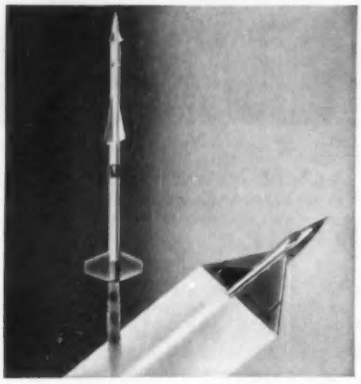
United States Gasket Co., Camden 1, N. J.

United States Gasket *Plastics Division of* GARLOCK



Creep Resistance at 300°-700° F.

In this temperature range, use the thorium-containing alloys of magnesium. They are the only satisfactory metals which combine creep resistance with good strength and light weight.



For designers of high speed jet planes, rockets, and guided missiles, this solves a problem. Formerly it was thought necessary to use heavy materials. They are less satisfactory than these magnesium alloys.

Formerly available in the form of castings only, thorium-containing magnesium alloys now come in rolled sheet. B&P's mill produces this sheet.

B&P engineers will help you redesign in magnesium. B&P offers the magnesium industry's most complete facilities for fabrication and assembly. Your inquiry will bring a descriptive booklet.

BROOKS & PERKINS, Inc.

LIGHTNESS . . . **PLUS!**

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DETROIT 16, MICH.

D-3

ordinary cold-rolled steel, for example, can be machined by conventional methods more rapidly and with complete satisfaction, so that the Anocut process should not even be considered for such materials.

To Order SP No. 320 . . . on which this article is based, see p. 5

Controlling Variable Turbine Inlets

Based on paper by

R. E. MATZDORFF and C. F. NEWBERRY,
Marquardt Aircraft Co.

CORRECT matching of inlet ductwork to jet engine demands, and accurate control of variable inlet geometry are prime requirements for maximum thrust under all operating conditions. The first step is to design a variable inlet to meet changing speeds, altitudes, airplane attitudes, and power requirements.

This can be accomplished with an internal or external inlet shock pattern. Efficient designs will have a large number of shock waves of equal strength to minimize the total pressure loss across the shocks. The geometry of the inlet, its boundary layer control, and bypassed air must be varied with changing flight conditions to meet the efficiency objective.

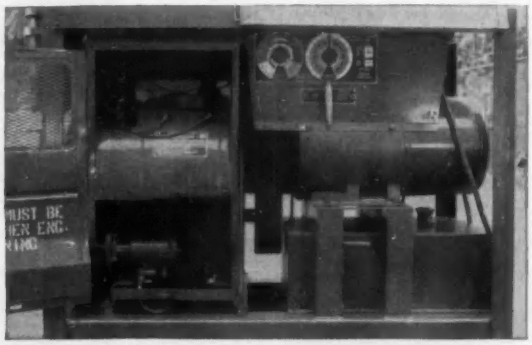
External shock inlets have simple internal flow patterns but can starve the engine if their shock pattern doesn't intersect the cowling. Internal shock inlets are not bothered with this problem but require careful compression surface control to prevent expelling the shock.

The second requirement can be met by inlet controls of the closed loop or scheduling type. The closed loop senses the flow characteristics in the inlet and changes its geometry accordingly. The scheduling type changes the inlet geometry as a function of external parameters, such as airplane Mach number and attitude.

Two pressure pickups are used for the closed loop system. One pressure, the signal pressure, must reflect the net propulsive thrust. This pressure tap is always located within the inlet or on a compression surface. The second pressure is a reference pressure for comparison with the signal pressure. The reference pressure point must be chosen to follow the desired performance of the inlet.

The signal pressure should have a high rate of change near the optimum

3,143 operating hours *with only minor adjustments with this* 400 *amp.*



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On-the-job service is what counts most in an engine. Here, for example, is a brief summary of a service report covering the performance of the Model VR4D 56 hp. Wisconsin Heavy-Duty AIR-COOLED Power Unit which drives the 400 Ampere Arc Welder illustrated above:

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This is another typical case of outstanding service delivered by Wisconsin Heavy-Duty Air-Cooled Engines on many kinds of equipment. Basic load-holding High Torque, heavy-duty design and construction in all details, foolproof all-weather Air-Cooling and *exclusive specialization* in the design and manufacture of AIR-COOLED Engines are some of the factors that are responsible for Wisconsin Engine preference wherever dependable, economical power is required.

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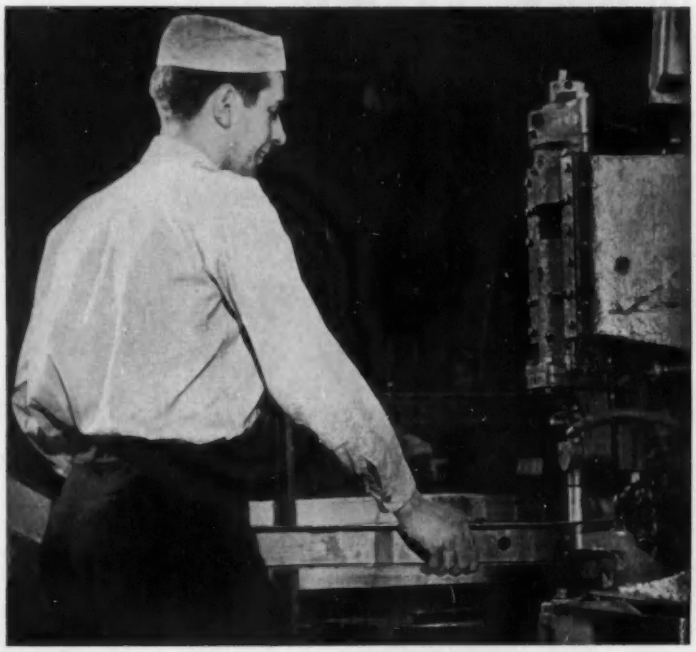
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operating value and be single valued.

An example of two such pressures is a static signal-pressure tap at the location of the normal shock in an internal shock inlet, and a total reference-pressure tap at the same location.

In the closed loop system the geometry of the inlet can be actuated by electrical or hydraulic means. However, the hydraulic method tends to have fewer parts and is therefore more reliable.

To Order Paper No. 236 . . . on which this article is based, see p. 5.

CO_2 Compares Favorably With Other Weld Shields

GAS-SHIELDED consumable-electrode welding of carbon steels with CO_2 is now yielding results fully comparable to earlier successes with more costly argon. In some respects, CO_2 results are slightly better. Mechanical properties of CO_2-shielded welds are comparable, too, with those produced with low-hydrogen electrodes.

As compared to argon-shielded welding, the CO_2 type:

- Is less costly.
- Requires a smaller flow for adequate shielding.
- Results in welds whose physical qualities are comparable.
- Gives less favorable bead appearance.
- Gives slightly broader penetration.
- Gives welds with more tendency toward undercutting.

Three types of CO_2-shielded welding are being currently used:

1. Solid wire with CO_2 shielding.
2. Solid wire with CO_2 plus flux shielding.
3. Hollow flux and wire with CO_2 shielding.

The cost and quality required for any given job should determine which of the three types is used.

At present, wires available for CO_2 welding consist mainly of two types in the 60,000–70,000 psi tensile range. One type consists of highly deoxidized wires for welding rimmed or unclean steel. The other, of wires containing a medium amount of deoxidizers for welding clean semikilled or killed steels. In neither case do the deoxidizers markedly affect the alloy content of multilayer welds.

"Burn through" (or "plow through") welding—a recently applied form of CO_2-shielded arc welding—requires less joint preparation than do conventional welding methods. This process consists of welding through the solid plate of one member into another. It is possible to join several thicknesses in this manner. Its cost—as related to seam welding, for example—depends upon

Goodfriend report on tire noise shows rayon 10-33% quieter

Tires made with rayon cord are measurably quieter than tires made with the other cord. That is the authoritative testimony resulting from tests completed by Lewis S. Goodfriend and his associates of Scarsdale, New York.

These noise level studies now give precise scientific measurement to the noise differences that drivers are aware of—differences that can affect conversation in the car.

Even at extremely low speeds—20 m.p.h.—the difference in noise is a significant 10%. At highway speeds of 50 to 60 m.p.h., the difference rises to 33%. As the report states it:

"It is our conclusion that tires made with the other cord create from 1.2 to 4.3 times the noise intensity of rayon cord tires when operated at the same speed for speeds ranging from 20 to 60 m.p.h. We may further conclude that these intensities correspond to differences in loudness between 10% and 33%. Based on these conclusions, it may be stated that it is easier to converse at normal speaking levels and less attention is required to listen to speech while riding in cars equipped with rayon cord tires as compared to riding in similar cars equipped with tires made with the other leading cord."

The tests were made using a 1957 Oldsmobile equipped with first-line, four-ply 8.50 x 14 rayon cord tires and tires made with the other cord at different times during the tests. The two sets of tires had the same tread design and differed only in their type of cord.

For all of the tests, the automobile was operated for approximately one hour, with the test tires inflated at 24 pounds pressure—then parked for 8 to 10 hours so that any tire characteristics developed while parked could become apparent. Following the standing period, recording equipment was placed on the rear seat of the car. The equipment was allowed to warm up for five minutes, and the tape recording started. Car windows and vents were closed throughout the test runs.

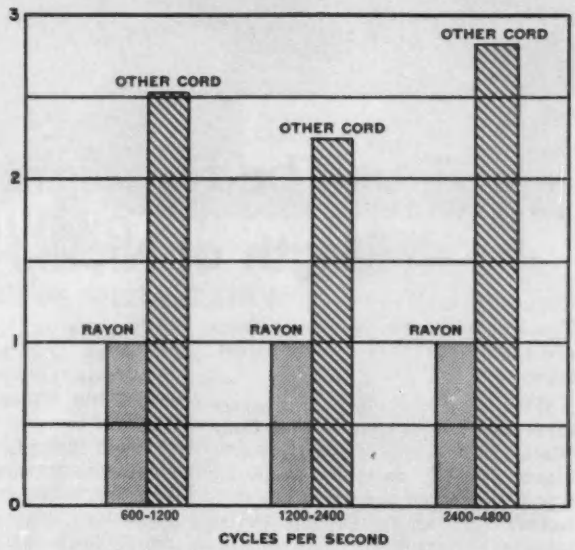
Following completion of the preliminary tests, recordings were examined by means of both an octave-band analyzer and the cathode ray oscilloscope. The information from the analysis was used as the basis for planning a second series of tests.

Recordings from the second series of tests were analyzed by making loops of tape for various operating conditions. It was then possible to study the comparative noise properties of the other cord and the rayon cord under each condition for a considerable length of time. The tape loops were reproduced through an octave-band analyzer and the sound levels for each octave band were recorded. Photographs were made of oscilloscope patterns, showing the characteristics of the waveform of the sound waves produced by the tires.

Analysis of each tape loop consisted of noting the octave-band noise levels and taking photographs of the oscilloscope patterns which show the relation between steady and intermittent tire noises. The entire tape was examined for background and peak noise levels.

Significantly, the report points out that, "the bands from 600 to 4800 cycles per second are critical with regard to the understanding of speech and it becomes increasingly more difficult to understand speech when the average of the three octave-band levels in those ranges rises above 55 decibels. Thus, the difference between the other cord and the rayon cord tires at speeds of 40 m.p.h. is of great importance with regard to the convenience of passengers in carrying on conversation. The higher noise levels created by the other cord tires in these bands which are critical for the understanding of speech will certainly cause persons in the car to speak in louder voices and will require more effort on the part of the listener than would be required under quieter conditions."

A full copy of the Goodfriend report is available by writing to: American Viscose Corporation, Tire Yarn Sales Division, 350 Fifth Avenue, New York 1, N. Y.



Relative intensities of rayon cord tires vs. tires made with the other cord in speech interference frequencies 50-60 m.p.h.

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the particular use being made of it . . . and requires an evaluation of the particular equipment cost, welding speeds, size of parts, and other factors.

— Consensus at an SAE Production Forum Panel on "Welding Methods and Process Control"—Albert J. Dearing, A. O. Smith Corp., secretary

To Order SP No. 320 . . . on which this article is based, see p. 5

Tips on Shaping High-Strength Materials

Based on secretary's report by

D. M. STUBBS
Lockheed Aircraft Corp.

PROFILE trimming operations using conventional routing techniques and equipment have been unsuccessful when attempted on titanium alloys and on high-strength corrosion-resistant steels. One large aircraft company's approach to this problem has been the modification of existing methods and equipment used for spindle shaping (or routing) of aluminum.

A survey of the major factors affecting tool performance, and thus limiting production, indicated cutter geometry, cutting speeds, and coolants to be the most important variables. The company's recommendations, resulting from data obtained in their tests, are as follows:

Equipment—Model 287 Oliver spindle shaper or equivalent. A minimum of 7½ hp is required, as well as a means of providing cutter speed variation from 2000 rpm to 10,000 rpm. The collet must not allow more than 0.001 total indicator reading on the cutter when set up for operation.

Cutters—The cutters should be of the carbide insert type with K1, or equivalent, inserts for 6A1-4V titanium and K2S, or equivalent, inserts for AM350, 17-7PH, and 15-7PH high alloy steels. For both titanium and steel, the axial rake angle should be 7 deg ± 2 deg, and the radial rake angle 6 deg ± 1 deg. Rigidity requirements dictate that cutter bodies be larger than 1 in. in diameter and that cutter shanks be larger than 0.75 in. in diameter.

Coolant—The coolant should be CO_2, expanded from liquid directly on the cutting tool, at its point of contact with the material, by means of two 0.023 in. ± 0.005 in. diameter orifices in cooling nozzles.

Technique—The maximum depth of cut should be 0.060 in. Removal of more material than this in one pass generates more heat than the coolant can dissipate.

The spindle rpm should be set to obtain approximately 800 sfm for titanium and 1600 sfm for stainless steel.

Initial feed-in of material at the onset of the cut is extremely critical, as excessive impact will cause immediate cutter failure. The thickness of cut can vary from 0.062 in. to 0.050 in. Profiling of titanium sheet less than 0.062 in. thick will result in premature cutter failure due to excessive unit pressure on the cutting edge. Spindle shaping of titanium sheet thicker than 0.187 in. generates such excessive feed pressures as to require multiple passes in processing the work piece.

For production operations involving large quantities of parts, it will be advantageous to provide power-feed equipment in order to stack-trim. The optimum material thickness (0.062 in. to 0.187 in.)

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SK 180	80	7000	1.75	650	Corrosive Chemicals
469	80	8000	1.80	1200	High speed, High Temperature Aircraft
SK 145	90	8000	1.80	800	
SK 187	80	9000	1.79	650	High Altitude Bearings
SK 188	65	7000	1.78	650	
SK 152	100	10000	1.75	650	Very hard material for bearings operating in liquid
SK 154	100	10000	1.75	650	
SK 157	75	7000	1.80	250	Appliance Seals
SK 176	80	7000	1.80	650	
SK 105	75	7000	1.60	500	Oil Seals
SK 175	75	7000	1.75	500	
304	80	9000	1.79	650	Vanes & Bearings
331	50	7000	1.74	800	Turbine Rings
P87	70	6000	1.68	650	
Y20	40	3000	1.85	650	
SK 21	45	7000	2.70	250	
SK 87	70	7000	1.77	250	
SK 201	50	7000	1.79	800	
378	65	8000	1.78	650	
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requires only a portion of the cutter to be in use at a time. This allows the tool to be moved up or down, presenting a new cutting surface to the material without changing cutters. Tool area expectancy has been in the order of 375 lineal inches for 0.125 in. thick heat treated titanium and from 30 to 144 lineal inches for the same thickness stainless steel, depending upon heat treat condition.

The tests from which this information was obtained were considered to be preliminary in nature, and data obtained from them do not preclude the possibility that further work along this line may yield information toward refinement of the technique. Also on the panel which developed the information in this article were: **J. B. Bierbower,** Lockheed Aircraft Corp.; **O. Walker,** Ryan Aeronautical Co.; **R. H. Henke,** Allegheny Ludlum Steel Corp.; **L. S. Busch,** Mallory Sharon Titanium Corp.; **J. W. Price,** Douglas Aircraft Co.; **G. P. Campbell,** Boeing Airplane Co.; and **H. W. Bloom,** North American Aviation, Inc.

To Order SP No. 321 ... on which this article is based, see p. 5

Current Truck Cab Trends to Continue

Based on paper by

THEODORE ORNAS
International Harvester Co.

FUTURE cab designs will continue to follow established trends in both heavy- and light-duty lines. The truck cab will of necessity begin to develop a separate identity design-wise from that of the passenger-car body. More and more attention will be given to the interiors in an effort to accomplish the maximum in driver comfort and protection. The use of the word "functional" when referring to the new interiors will not imply bare minimums. Tomorrow's functional interior will mean arrangements designed for efficient driver operation.

Noise level, one of the contributing factors to fatigue, will be reduced. Controlled cab air temperatures will be in demand and reduction in cab and front end lengths will necessitate new package developments of air conditioners. Lower overall heights will be a continuing objective. Improved engine accessibility to facilitate maintenance will be a prominent design factor.

The light-duty truck will receive special attention as far as interior appointments for appeal to the truck buyer. New materials will be utilized to give cab interiors a softer, more luxurious appearance, and color will become more important in the product.

The accent on lowered silhouettes

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This Mather counter balance system for tilt cab vehicles provides both manufacturers and service organizations with many advantages. It enables the manufacturer to design and engineer for a short wheel base cab, with complete clearance for mounting engines to the most desired forward position.

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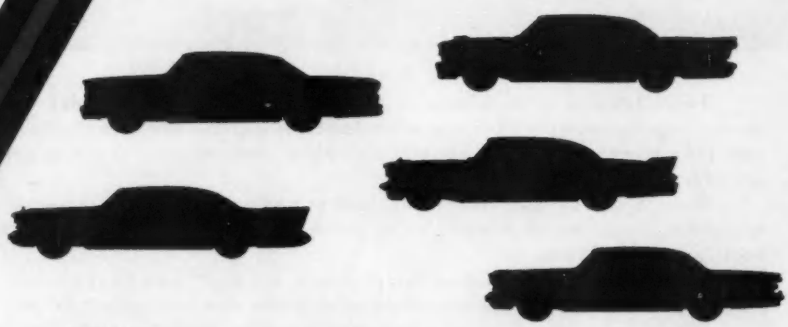
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will be a greater factor in designing for customer appeal. Height will be predicated on new chassis and engine developments and also to what extent the consumer is willing to sacrifice ground clearance in truck application.

Economics will also determine future cab design. Smaller trucks and lighter cabs will aid economy of operation necessary for truck use. The light pickup could very likely assume an entirely different shape. Depending on new powerplant design, the normal front end could disappear and leave the cab proper as the dominant feature of the overall design. The shape of the truck is constantly changing.

The ever-growing accent on appearance, which is bringing the industrial designer or stylist into the picture, will bring about greater improvements in overall design.

Stylists, their imaginations racing ahead of advancing technologies, will continue to project their thinking into unorthodox realms. In their styling studios, airbrushed renditions of the truck of tomorrow will appear. Whether their dreams and sketches materialize into actual trucks depends primarily on one thing: Will it do the job for the customer? Not the least is this factor: Will the customer buy it?

To Order Paper No. 19A . . . on which this article is based, see p. 5.

Belt Slab Grinding Provides Weight Control

Based on paper presented as part of a panel by

DAVID E. WOOLMAN
North American Aviation, Inc.

THE removal of material by belt grinding from the entire face of the worksheet on each cycle of the feed mechanism is called belt slab grinding. The process represents one engineering approach to lighter aircraft-weight control.

Let us consider two specific areas where weight control is provided by belt slab grinding. First, the grinding of a good vacuum chuck surface on the work prior to pocket machining, and second, the reduction of the worksheet to any nominal thickness commensurate with engineering design requirements.

By improving the vacuum chucking surface of the work, lower tolerances can be obtained in subsequent pocket machining and better weight control can be expected by the design groups. Test runs on production-size pocketed skins, belt slab ground, have produced machined surfaces to 0.004 in. maximum deviation over areas up to 36 × 96 in.

Weightwise, structural requirements can best be met by utilizing the nominal thicknesses needed. Design weight problems are further aggravated by the overweight condition of most of the "as-received" material.

Most high-temperature metals have a tolerance spread of ±0.010 in. Belt grinding can produce a ±0.002 in. tolerance or less on most thicknesses of sheet.

Physical limitations of the mills at the present time, on most of the thermal-resistant metals, force the sheet tolerance toward the heavy side. Because of this condition, considerable weight can be saved on high-temperature airframes by belt slab grinding all sheet and plate prior to their use in detail parts.

Two types of belt slab grinding machines are being used for development tests. The first is a carrier-type machine in which the work is held on a table and carried back and forth under the grinding belt. The second is a pinch-roll type machine in which the work is pushed into and pulled out of engagement with the grinding belt.

To Order Paper SP No. 321 . . . on which this article is based, see p. 5

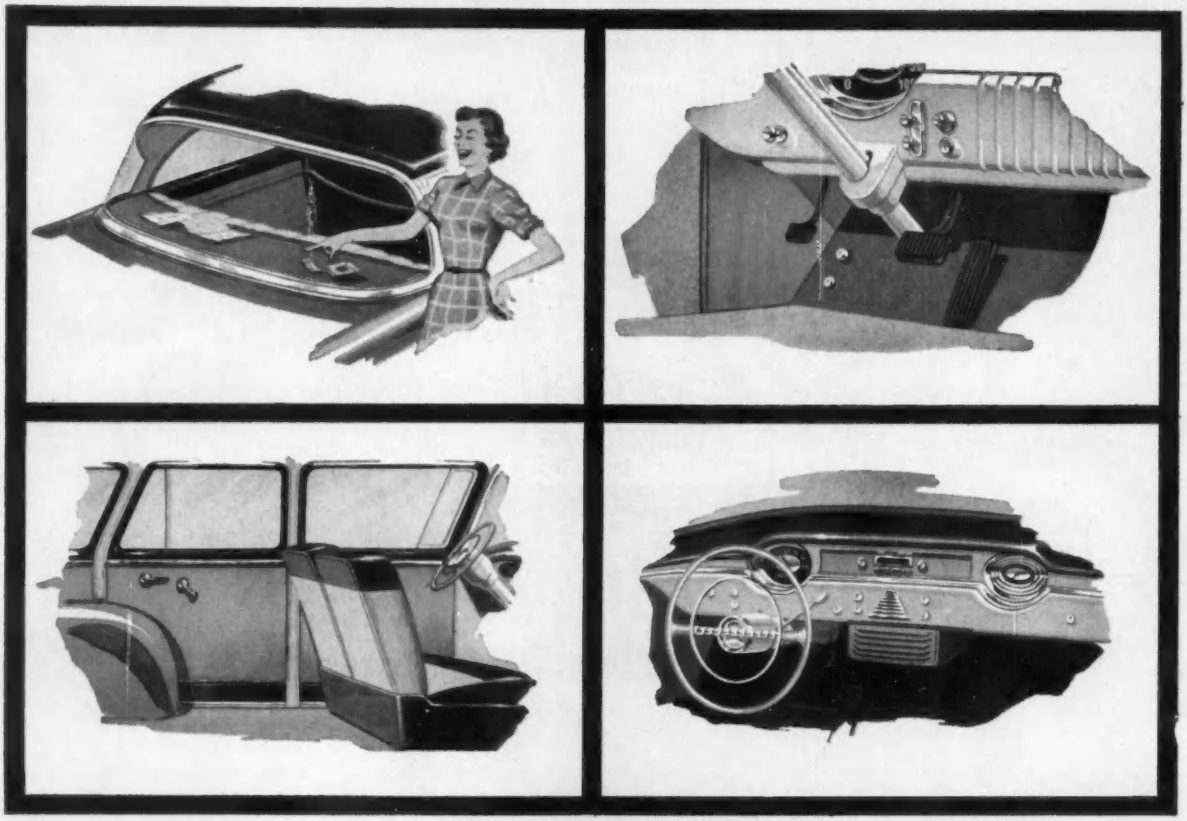
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DIST. OFFICES: Akron • Boston • Gastonia • Chicago • Los Angeles • Memphis • New York • Phila. • CANADA: Latex Div., Dominion Rubber Co., Ltd., Montreal • CABLE: Rubexport, N.Y.

New Members Qualified

These applicants qualified for admission to the Society between December 10, 1957 and January 10, 1958. Grades of membership are: (M) Member; (A) Associate; (J) Junior.

Alberta Group

Kenneth Dixon Kirkham (M).

Atlanta Section

E. I. Bricker (M), Harry Nelson Edmondson (M), Robert O. Hallen (M), Charles Harold Rutledge, Jr. (M).

British Columbia Section

Edgar P. (Ted) Church (J), Gwynn Jenkins (M).

Buffalo Section

Robert James Caulfield (J), Robert B. Clapper (M), John W. Godfrey (M), Heldur Ronald Ratnik (J), Floyd H. Walters (M).

Canadian Section

Leo John Cada (M), Charles Stuart Dempsey (M), W. Cameron Durie (J), Norman Robert Kitchen (J), Richard A. Knowlton (A), Gunder Osberg (M), J. W. Palframan (M), W. A. Paterson (M), Russell R. Tartaglia (M).

Central Illinois Section

Celius Robert Anderson (M), Wallace M. Catanach, Jr. (J), Byron S. Fierce (J), Milan Boyd Hendricksen (J), Marvin C. Keys (M), Kenneth R. Moline (M), Sebald K. Stahl (J), Robert George Symonds (J).

Chicago Section

John F. Antrim (M), Carl F. Brock (J), David Blair Digel (A), John James Durkin (J), John T. Ellis, Jr. (M), Angelo M. Gabriel (J), Edward C. Harnach, Jr. (J), A. Peter Huffmire (A), Cliff Morris (A), Bernard J. O'Halloran (A), M. E. Samuelson (M), James W. Scott (A), John Talamonti (M).

Cincinnati Section

William S. Davidson (J), John I. Hamilton (A), Donald P. Holmes (J), James Arthur Maston (J), Alex B. McLennan (A), Victor John Trickett (M), Robert A. Winblad (M).

Cleveland Section

Russell Joseph Bouchez (J), Charles N. Drechsel (J), Charles A. Hall (M), Gene E. Myers (J), Peter Abba Orner (J), William H. Tobener (M), Richard L. Wann (M).

Dayton Section

Harold R. Fouss (A), Norman Chris Johnson (J), Walter E. Moore (M).

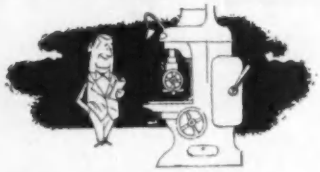
Detroit Section

Bohdan A. Andrushkiw (J), George Arthur Berman (M), Robert A. Brau-



ATTEND THE
1958
ASTE
TOOL SHOW
CONVENTION CENTER
PHILADELPHIA MAY 1-8

SEE all the very latest advances and improvements in more than thirty major categories of industrial products.



ATTEND top-level conferences, conducted by recognized authorities on the newest production techniques and developments.



MEET and exchange ideas with management, engineering, production, sales people from the nation's leading industrial concerns.



INSPECT the modern equipment and up-to-the minute manufacturing methods being utilized in booming Delaware Valley plants.



AMERICAN SOCIETY
TOOL SHOW CONFERENCE '58 MAY 1 TO 8
OF TOOL ENGINEERS

New Members Qualified

Continued

berger (M), Bruce R. Cable (J), Herbert R. Carrier (M), William D. Casey (J), Lloyd Keith Covelle, Jr. (A), Robert F. Falberg (M), Harold Saum Ford (J), Ronald Glen Frakes (J), Daniel T. Franklin (J), Herman J. Greif, Jr. (J), Gerhard Karl-Friedrich Haas (J), E. Eugene Hancock (J), Alfred L. Hylton (M), Leigh F. Jackson (J), Gerald E. Jerome (J), Donald A. Karalash (J), Robert E. Kay (J), Paul John Lampela (J), Roy M. Law (J), James L. Lempke (J), James Michael Marzen (J), Robert Hudson McRae (A), Norman W. Miller (J), Donald Wilbur Mold (M), Neil A. Newman (J), Loring F. Nies (J), Leslie J. O'Donoghue (M), John L. Pappin (M), R. Graydon Robling (M), Vernon Arthur Rosell (J), George Frederick Schnell (M), Martin Seitz (J), Harutyun Simsar (J), Herbert D. Smith (A), Lloyd J. Stanbery (M), James R. Stimpson (J), W. L. Tomlinson (M), Raymond Violante (M), Edgar R. Whitney (J), Alverson B. Williams (J), Donald Lee Willoughby (M).

Indiana Section

Arthur Allen Boyers (M), S. R. Conwell (M), William G. McLaughlin (M), Gene Rexford Moulton (J), Richard Loren Staadt (J), W. W. Ulrich (M).

Kansas City Section

Ralph E. Gustafson (M), Elmer E. Litton (J).

Metropolitan Section

Lloyd G. Angeloff (J), Donald B. Barbieri (J), Bohdan R. Berezynycky (J), A. Bringewald (M), Robert M. Flanagan (M), Sanford Halter (M), Dudley T. Himoff (M), Simon H. Kahn (J), Clarence R. Libby (M), Mario L. Marchese (J), Lewis Edwards Minkel (A), John F. Moult, Jr. (M), Richard F. Neblett (M), Neal Alan O'Keefe (J), Bernard Rome (J), Major Robert W. Samuel (M), Wilfrid M. Thomson (M), K. F. Wasmuth (M), Thomas L. Wiegand (J).

Mid-Continent Section

Joseph Milton Case (J).

Mid-Michigan Section

Theodore N. Louckes (J), Thomas W. McWhirter (J), Ronald Miller (J), Edward J. Stadler (J), Bill A. Stout (J), Elvin E. Tuttle (M).

Milwaukee Section

Charles F. Alexander, Jr. (M), Ben Grob (M), Lester M. Koelsch (M), Charles E. Moeller (A), David Charles Schweitzer (J), Edward Charles Slagis (J).

Mohawk-Hudson Section

James W. Cummings (A), Elmer J. Phillips (M), Charles A. Smiroldo (A).

Montreal Section

J. E. Lavigne (A), Roger Legault (J), John Charles Morris (A), Allan Burrell Newland (M), Frank Sicard (A), Greg. G. E. Trudel (J).

New England Section

Wesley Gordeuk (M), Jack Ward Myers (J).

Northern California Section

Terence R. Alchorn (M), Robert D. Cowger (A), Ralph T. Evans (J), Percy Elmer Harmon (A), Arthur Norbert Stodola (J), Walter E. Vance (M).

Northwest Section

Kenneth John Fehrenz (J), Ralph B. Flaaten (J), Hideo Kawata (J), George H. Weaver (M), Ronald Alfred Winger (J).

Oregon Section

Robert B. Gaulke (A).

Philadelphia Section

John S. Gillespie (A), William G. Mikell (M), Dennis C. Slattery (J), Al Lawrence Smith (J), Richard Ellis Turner (J).

Pittsburgh Section

John Marion Coffen (J), Frank J. Kowalski (J), Russsell L. Mathias (M), Alexander Harold Matz, Jr. (J), D. L. Moses (M), Luis Alberto Ricardo (J).

St. Louis Section

T. J. Busch (M), Ralph W. Shipp (J).

Salt Lake Group

Raughn Earl Taylor (J).

San Diego Section

Ernest A. Bigelow (J), Sam E. Blumberg (M), Vair Carr Lacey (J), Robert James Mack (J), James H. Winger (J).

South Texas Group

Thomas James Patterson (J).

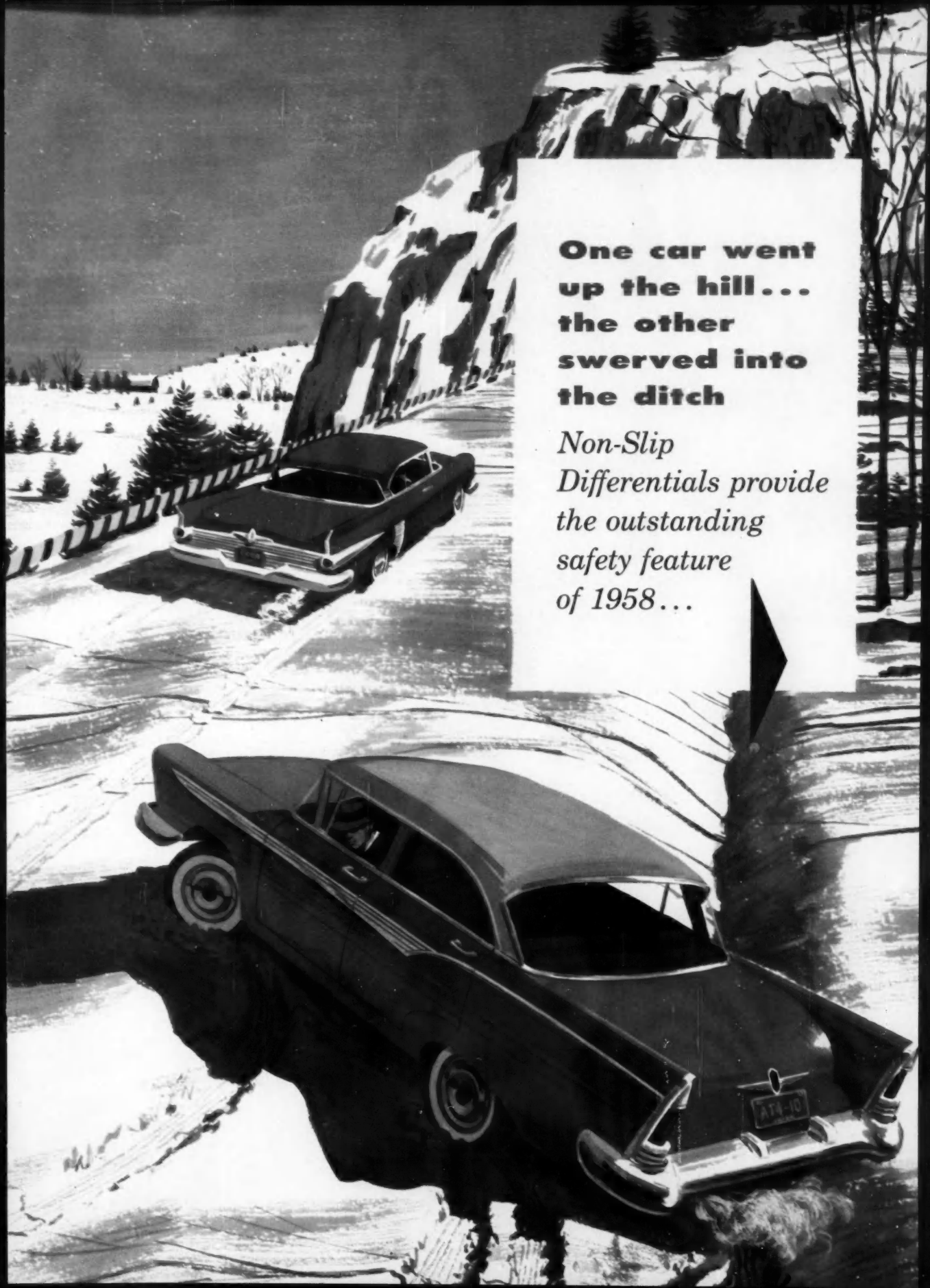
Southern California Section

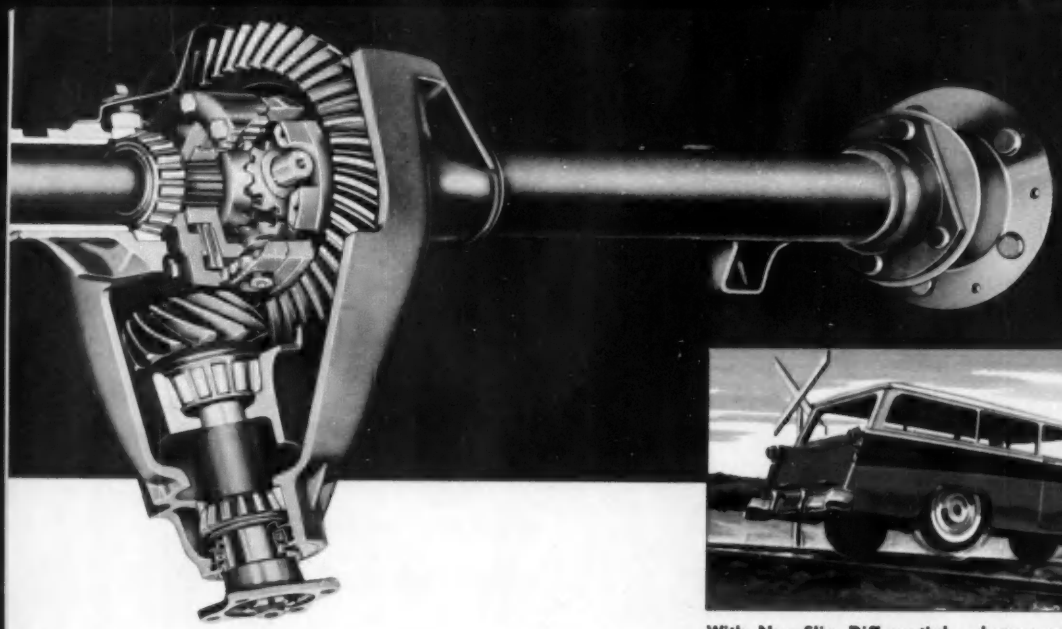
Leslie LeRoy Allen (J), William H. Bettes, Jr. (J), Warren V. Boughton (M), Bert Martin Frey (J), Donald Roy Gates (J), Robert D. Kunkle (M), Glenn Milton Laitinen (J), Robert E. McCall, Jr. (M), James A. Merriam (A), Gene Pierre Monden (J), Gene Harold Pearson (M), Jules A. Peebles (J), 1/Lt. Mackey J. Real, Jr. (J), James J. Rodriguez (J), Edwin U. Sowers, III (J), James Donald Timm (J), Charles Crosby Turner, Jr. (M), Juji Wada (J), Paul D. Whittington (J).

Southern New England Section

Carter D. Bragdon (M), Howland Seymour Foote (J), Albert A. Marchetti (M), Gudmundur P. Peterson (M), Edward R. Primachuk (J), John S. Spring (J), Robert J. Valentine (M),

Continued on page 139


One car went up the hill... the other swerved into the ditch
Non-Slip Differentials provide the outstanding safety feature of 1958...



With Non-Slip Differentials, dangerous car swerve and unbalance caused by wheel-hop and spin on rough, bumpy roads is ended, because the power is immediately delivered to the wheel with the most traction.

Sell Non-Slip Differentials...

you'll sell more cars in 1958

Ordinarily, if one of your wheels can't get traction . . . you're stuck. That's because with conventional differentials all the power goes to the wheel that has no traction. The result . . . you just spin your wheels. But, with Non-Slip Differentials, power is delivered to the wheel that has the most traction. So if either wheel can catch hold, there's no slipping, sliding, wheel-hopping, or getting stuck. You're safer in a car with Non-Slip Differential.



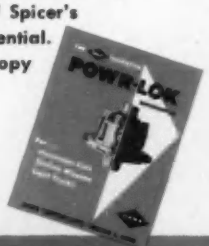
Mud and sand won't stop you—if either rear wheel has traction. Non-Slip Differentials power you right through muck and mire that stops conventional differentials cold.



If either rear wheel can catch hold, Non-Slip Differentials prevent slipping, sliding on icy or wet pavement. Puts an end to getting stuck in driveways, or at curbs.



FREE **This 12-page booklet is a complete and well-illustrated explanation of Spicer's Non-Slip Differential. Write for your copy today. No obligation.**



DANA CORPORATION • Toledo 1, Ohio

DANA PRODUCTS Serve Many Fields:

AUTOMOTIVE: Transmissions, Universal Joints, Propeller Shafts, Axles, Powr-Lok Differentials, Torque Converters, Gear Boxes, Power Take-Offs, Power Take-Off Joints, Clutches, Frames, Forgings, Stampings.

INDUSTRIAL VEHICLES AND EQUIPMENT: Transmissions, Universal Joints, Propeller Shafts, Axles, Gear Boxes, Clutches, Forgings, Stampings.

AVIATION: Universal Joints, Propeller Shafts, Axles, Gears, Forgings, Stampings.

RAILROAD: Transmissions, Universal Joints, Propeller Shafts, Generator Drives, Rail Car Drives, Pressed Steel Parts, Traction Motor Drives, Forgings, Stampings.

AGRICULTURE: Universal Joints, Propeller Shafts, Axles, Power Take-Offs, Power Take-Off Joints, Clutches, Forgings, Stampings.

MARINE: Universal Joints, Propeller Shafts, Gear Boxes, Forgings, Stampings.

Many of these products manufactured in Canada by Hayes Steel Products Limited, Merritton, Ontario

DANA
Spicer

New Members Qualified

Continued

Edmond Rich Vianney (M).

Spokane-Intermountain Section

Robert G. Flagan (M).

Texas Section

Joseph Alonzo Ramirez, Jr. (J).

Texas Gulf Coast Section

Eric Hamm (A), Irving Pollock (M), W. W. Starr (M).

Twin City Section

Arthur H. Abrams (J).

Western Michigan Section

Richard Davis Follrath (J).

Outside Section Territory

Gene Richard Drew (J), Edward Perry (Pete) Espenschied (J), Leonard I. Gatzke (A), Charles E. LaBelle (J), Andrew E. Litwin (J), Elwood H. Robinson (A), John H. Stager (A), Charles Wayne Taylor (J), Robert C. Tefft (J), Robert H. Tweedy (M), Edwin A. Weaver (J).

Foreign

Maxwell Ernest Brownell (A), Australia; Kenneth Gilbert Eckford (M), South Africa; Osama Amin El-Kholy (M), Egypt; Cyril Fountain (A), England; Oswald W. Geromiller (M), Germany; Kotcherlakota Sri Rangasai (J), India; Geoffrey Francis Sheppard (M), England.

Applications Received

The applications for memberships received between December 10, 1957 and January 10, 1958 are listed below.

Atlanta Section

R. Jack Alexander, Jr.

Alberta Group

Ronald Henry Allen

Baltimore Section

John F. Roderick, Frederick Allen Sliger, R. M. Weitzel

British Columbia Section

Delphi Joseph Bortolin

Canadian Section

Ronald J. Crichton, Arthur John Lake, John E. McCormack, Gordon K. Trenholm

Central-Illinois Section

Keith Eugene Demorest

Chicago Section

William C. Gage, Donald B. Judsen, Carl W. Miller, Walter Murelis, Donal Dinwiddie, Ralph D. Nelson

Cleveland Section

Norman R. Gay, Bartholomew J. Kitko, Harold M. Straub

Colorado Group

Jack P. Goodman

Detroit Section

Alan P. Anderson, Jack R. Barthlow, Warren G. Bopp, Roland A. Brandau, Donald E. Cardoze, Wayne K. Carson, Thomas B. Case, Wilbur H. Clevenger, Glen A. Cole, James Cumming, Horace Eugene Dawalt, Roger T. Goulet, George A. Grossman, Donald R. Herpel, F. R. Householder, Paul G. Johnson, James L. Jonas, Kenneth Latwinski, Joseph Laurence, R. A. Maxwell, Kenneth McBroom, Leonard P. Paddy, Stanley Parr, Donald Pauck, Josue R. Picon, Edward B. Porter, John William Romig, David A. Rozich, Wendell "Bud" Semelroth, Fred Sherman, Robert L. Thrun, Edward P. Tighe, Richard H. Topp, Wayne A. Weaver, James W. Wells, Richard W. Wixom, James F. Yevtich, Frederick Wolf Zappert, Frank

Continued on page 140



Applications Received

Continued

W. Zawodni, Axel Zisis

Hawaii Section

George M. Talbott, Nathan H. Tracy

Indiana Section

Thomas A. Bank, Robert Wesley King, James A. Kuhl, Edward T. Mabley, Robert E. McAfee

Kansas City Section

Oliver Gooch Phillips, Jr., William T. Royston

Metropolitan Section

Ronald Doran Eber, Ashok M. Khilnani, Raymond C. Kopituk, Hideo Matsunaga, Michael Cornell O'Connor, William J. Omerod, Jr.

Mid-Continent Section

W. L. Banks, Joseph S. Crawford, Lee Elden Fry

Mid-Michigan Section

Robert L. Carter, William James Johnston, Jack E. Kennedy

Milwaukee Section

Werner E. Isola

Mohawk-Hudson Section

Richard G. Austen

Montreal Section

Michael David Heritage

New England Section

M. R. Colgan, William A. Holmes

Northern California Section

Per K. Reichborn, J. W. Riesing

Northwest Section

John Arthur Ruggles

Oregon Section

Robert Eastman Cox

Philadelphia Section

Edward G. Barry, Ledo R. Carletti, Paul A. Murphy

St. Louis Section

Donald E. Riggs

San Diego Section

John J. Delaney, Walker G. Dollmeyer, Philip M. Prophett, Marshall G. Richards, Fred B. (Burt) Winslow

Southern California Section

Ralph S. Bennett, Ronald L. Dempsey, Robert S. Gardner, Dorian Good, Eugene R. Greishaber, Lowell C. Horwedel, Sidney Laham, Sidney Lampert, Wolfgang S. Lang, Bernard L. Messinger Frank T. Nemits, Valdemar Schmidt, Clyde R. Seitz, Gail P. Smith, C. H. Stevenson, Marvin S. Voth

Southern New England Section

Charles Martin Dean, Frank P. Rolf

Spokane-Intermountain Section

James T. Oliver, Darwin Jack Riegel

Texas Section

John E. Brune, Darol D. Travis

Texas Gulf Coast Section

George W. Brooks, William Walter Holt

Twin City Section

Gustav A. Larson

Washington Section

Raymond J. Pflum

Wichita Section

Kenneth Delaplaine

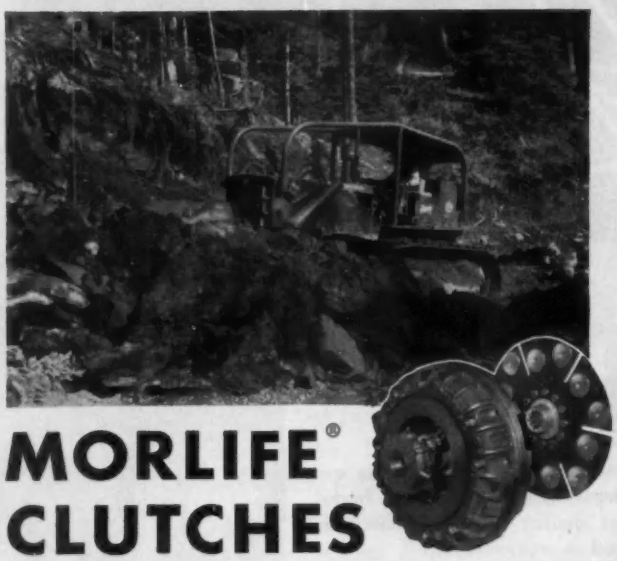
Outside of Section Territory

Donald I. Malm, Jackie Lee McDonald

Foreign

Rea Richard Franklin, Australia; Pablo J. Palomar, Spain; John Robert Pittman, Venezuela; Juan Carlos Quaranta, Argentina; Drago F. Volowsek, Argentina.

ROCKFORD



MORLIFE® CLUTCHES

Control Power Better in the Heaviest-Duty Machines

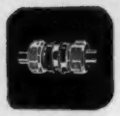
ROCKFORD Over-Center CLUTCHES, equipped with MORLIFE clutch plates, provide 100% more torque grip than previous type clutches of equal size. This permits the use of smaller diameter clutches. Easier operation is accomplished by reducing the required engaging pressure. 50% better heat disposal avoids down-time caused by burned or warped plates. Numerous field records prove that MORLIFE clutches operate 400% longer without plate replacement or adjustment. Let these NEW type clutches help improve the operation of *your* heavy-duty machines.

BW SEND FOR THIS HANDY BULLETIN
Gives dimensions, capacity tables and complete specifications. Suggests typical applications.

ROCKFORD Clutch Division BORG-WARNER
316 Catherine St., Rockford, Ill., U.S.A.
Export Sales Borg-Warner International — 36 So. Wabash, Chicago 3, Ill.


Small Spring Loaded


Heavy Duty Spring Loaded

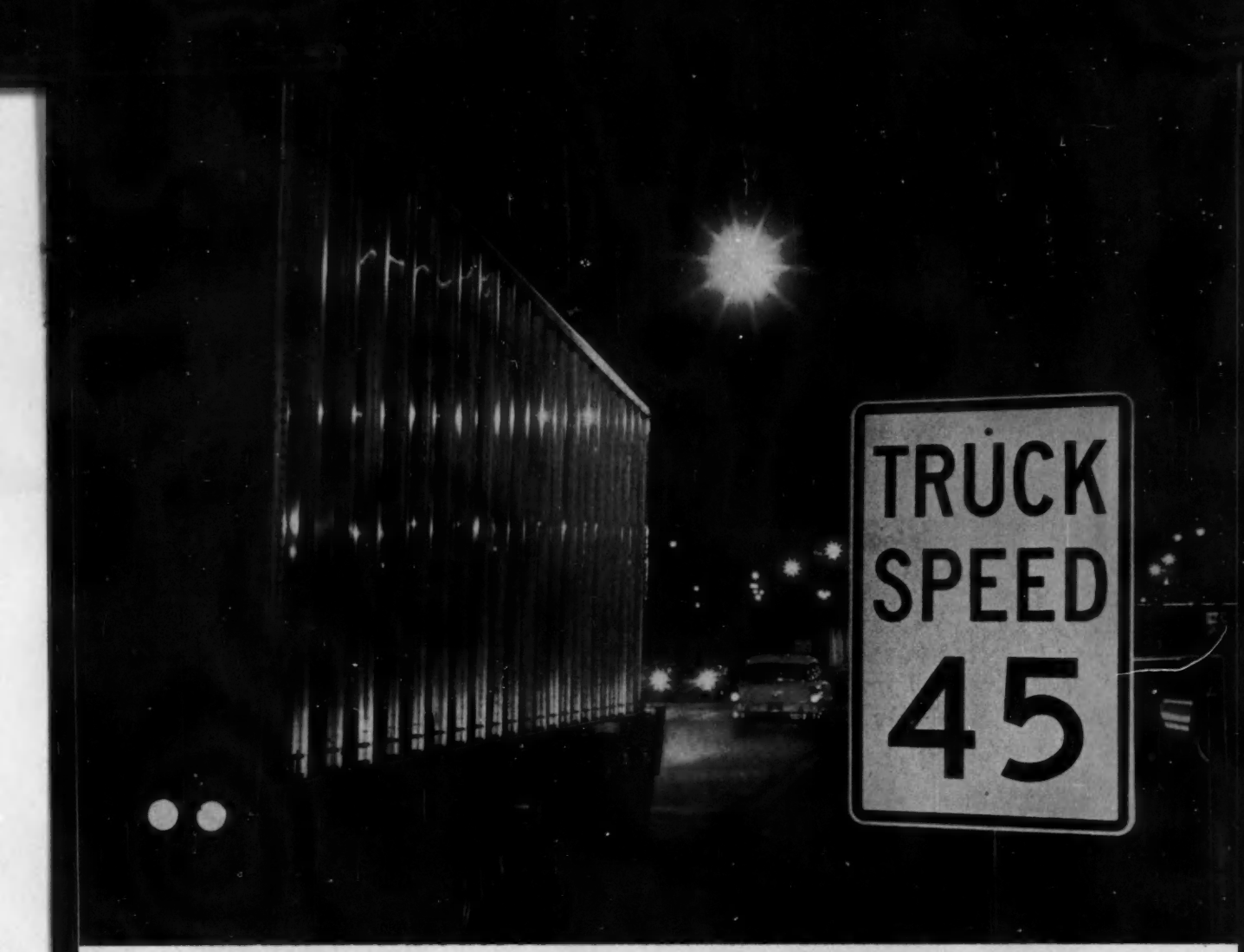

Oil or Dry Multiple Disc


Heavy Duty Over Center


Power Take-Offs


Speed Reducers

CLUTCHES



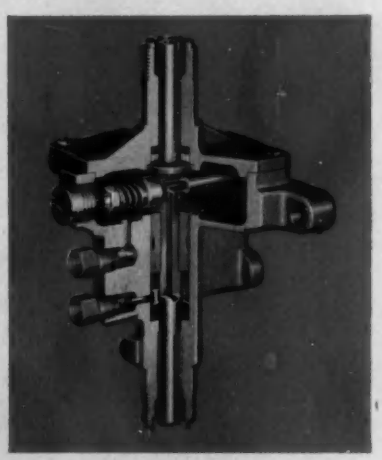
NOW—a truck governor that regulates road speed—not engine speed

For the first time, truck fleet operators can get accurate, predetermined economy results with all trucks by having all trucks operate at road speeds which have proven most economical. The new Holley roadspeed governor is driven relative to rear wheel speed instead of relative to engine speed. It can easily be calibrated for any truck gear ratio and has been successfully tested over thousands of miles of road conditions.

The Holley roadspeed governor can be used in conjunction with the engine speed governor. Thus, if the vehicle is running in one of the lower gears and the engine reaches its governed speed before reaching the predetermined mile per hour setting, the engine speed governor controls. In the event that road speed is reached prior to the engine rpm maximum setting, as in high gear, the roadspeed governor controls.

The roadspeed governor offers fleet operators a complete governing system designed to allow maximum horsepower under extreme load conditions and yet providing pinpoint control of road speed for maximum economy.

For more information on the Holley roadspeed governor, simply send a request on your letterhead.



The new Holley road speed governor, engineered to regulate actual road speed, is designed to eliminate mechanical trouble and prevent malfunctioning.

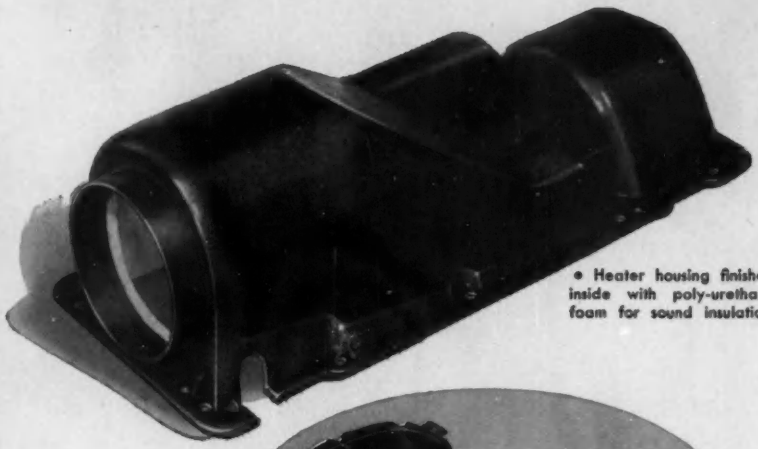
For more than half-a-century original equipment manufacturers for the automotive industry.

HOLLEY Carburetor Co. 11955 E. NINE MILE ROAD • WARREN, MICHIGAN

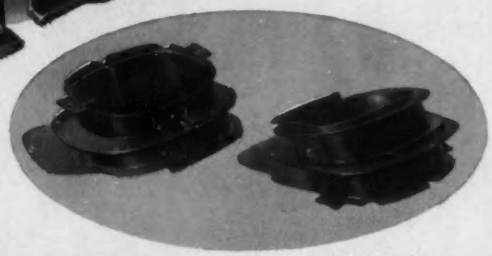
T-8



• Car air conditioning ducts covered with poly-urethane foam for thermal insulation.



• Heater housing finished inside with poly-urethane foam for sound insulation.



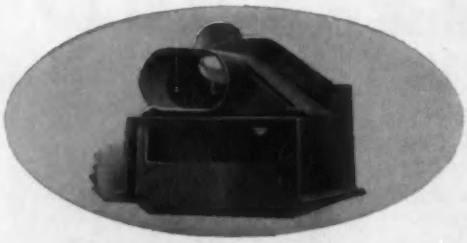
• Reinforced plastic shrouds for car side air duct outlets.

FABRICON

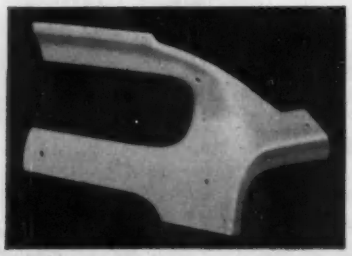
REINFORCED PLASTIC MOLDINGS



• Heater blower housing.



• Housing for air conditioning system.



• Exterior trim molding ready to be finished with a decorative simulated wood grain pattern.

Custom premix compounds plus new improved processing techniques permit economical volume production of intricate, complex parts

Intricate, complex parts are difficult to design and costly to make out of metals. That's why more and more design and production engineers are turning to Fabricon reinforced plastic moldings for the answers to their problems. For component parts like those shown here can be quickly, easily produced with relatively inexpensive tooling . . . formed at once into finished pieces that require no costly secondary operations. What's more, they are made of special custom premix compounds developed by Fabricon after years of working with all types of resins and fiber reinforcements. And they are processed by modern laboratory controlled molding techniques which assure consistent uniformity of quality plus the best possible combination of the physical properties required for each individual application.

Want detailed information on how Fabricon products, facilities and services can be of help to you? Just outline the nature of your problem for prompt engineering recommendations . . . or send print of part for firm quotation.

FABRICON PRODUCTS

A Division of The EAGLE-PICHER Company

1721 W. Pleasant Street • River Rouge 18, Michigan

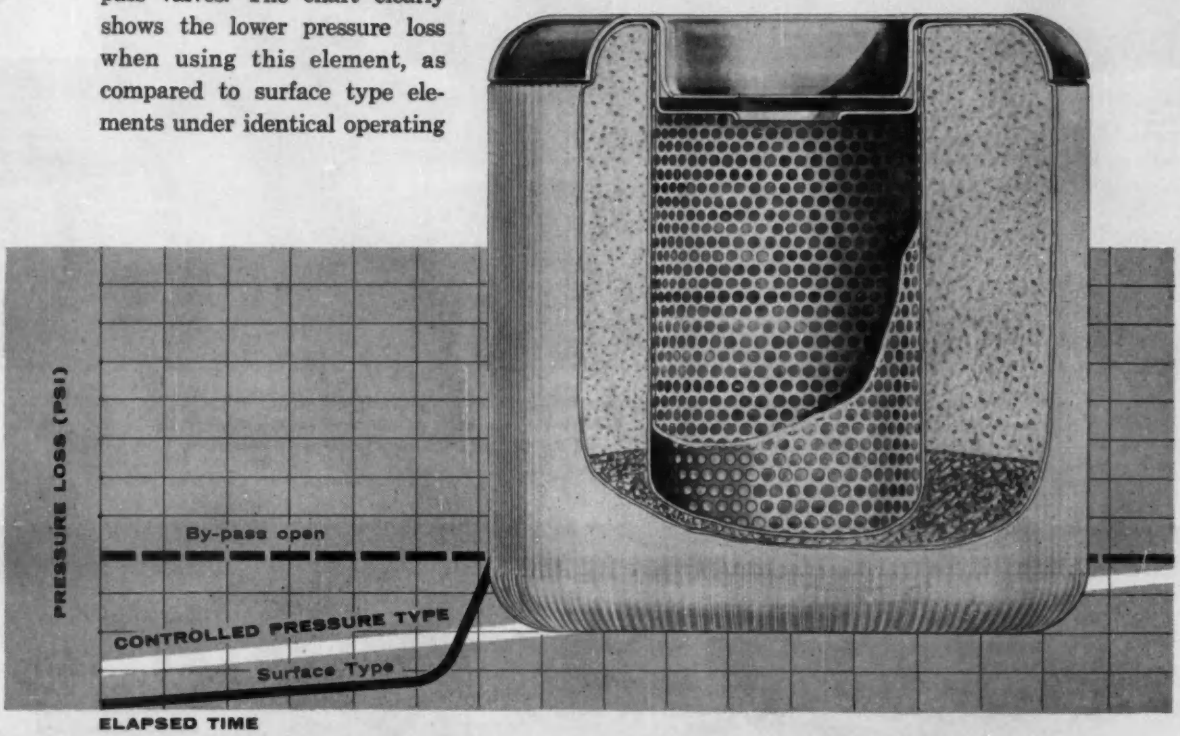


FORD STANDARDIZES ON DEPTH-TYPE FULL-FLOW FILTERS FOR HEAVY-DUTY TRUCK ENGINES

After exhaustive testing, Ford Motor Company has standardized on full flow type filter elements to insure maximum lubrication efficiency on its heavy duty truck engines. Regardless of service or weather conditions, full flow filtration of all lubricating oil will add further savings to the already established economical performance record of Ford trucks.

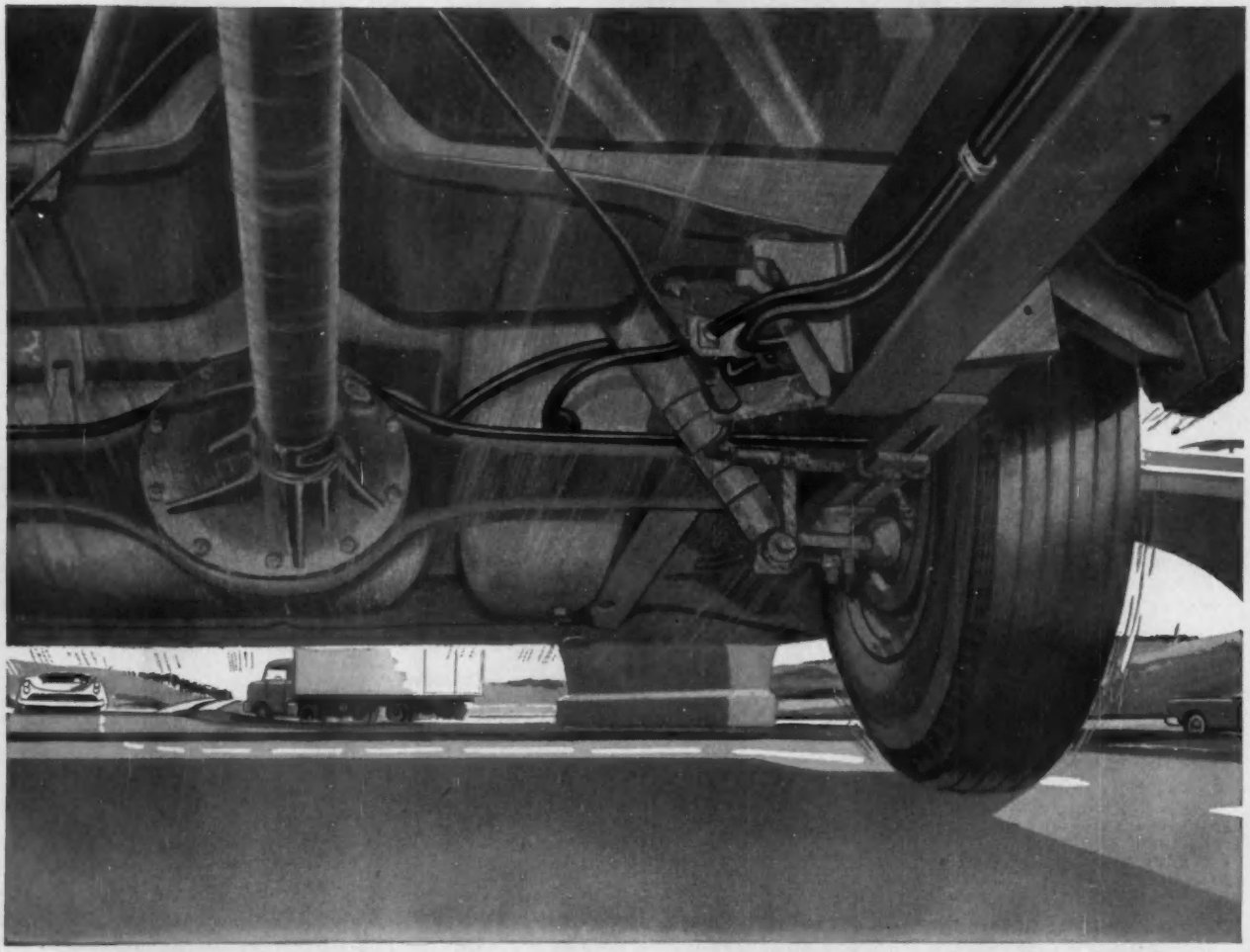
Exclusive Controlled Pressure Feature

The combination of two types of material within the same element is a patented feature of this full flow filter. This double flow capacity continuously self-adjusts pressure within the filter to allow for a full flow of filtered oil without opening by-pass valves. The chart clearly shows the lower pressure loss when using this element, as compared to surface type elements under identical operating conditions . . . how this element will extend the useful life of the oil. Reduced lubricating oil cost and greatly reduced engine wear are advantages indicated to Ford truck owners by the use of this filtration system.



FORD DIVISION OF FORD MOTOR COMPANY

High-powered cars need Bundyweld



Brake lines take a terrible beating from flying pebbles, pounding vibration. But brake lines made from double-walled Bundyweld take such punishment easily; stay leakproof. Result: supersafe driving for millions of motorists, over billions of miles.

BUNDYWELD IS DOUBLE-WALLED FROM A SINGLE STRIP



Bundyweld starts as a single strip of copper-coated steel. Then it's . . .



continuously rolled twice around laterally into a tube of uniform thickness, and



passed through a furnace. Copper coating fuses with steel. Result . . .



Bundyweld, double-walled and brazed through 360° of wall contact.



← **NOTE** the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.

full of "go" Tubing to STOP!

Increased weight . . . superhighway speeds call for extra-safe brake lines of Bundyweld Steel Tubing

More than ever, priceless lives depend on safe, sure stops. So remember, when you specify brake-line tubing: For complete safety in emergencies, *only* Bundyweld® Steel Tubing will do.

Double-walled from a single steel strip, Bundyweld stands up under high pressures, brutal shock and vibration fatigue . . . provides an unequaled safety margin. *95% of today's cars use Bundyweld for fuel, oil and hydraulic lines, averaging 20 applications each.* Over *two billion feet* have been used on cars, trucks and buses in the past 25 years.

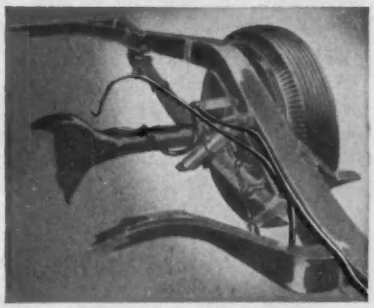
Save with Bundy® services: free, expert design and engineering aid at any product-development stage; fast, economical fabrication service with on-schedule delivery to keep lines rolling. Or Bundyweld is available in lightweight, easy-to-handle straight lengths for fabrication right in your own plant.

Whatever *your* tubing needs, you'll find there is no *real* substitute for Bundyweld Tubing and Bundy services. Find out for yourself why automotive engineers everywhere check *first* with Bundy. Call, write or wire us today!

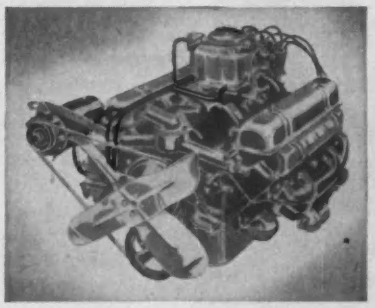
BUNDY TUBING COMPANY, DETROIT 14, MICHIGAN

WORLD'S LARGEST PRODUCER OF SMALL-DIAMETER TUBING • AFFILIATED PLANTS IN AUSTRALIA, ENGLAND, FRANCE, GERMANY, AND ITALY

Specify Bundyweld for every automotive-tubing use!



Gasoline lines can be pounded by stones, punished by vibration . . . still not collapse or leak when fabricated from Bundyweld. Why? It's *double-walled* from a *single* steel strip!



Oil lines that leak can cause delays, big repair bills . . . even ruin engines. So specify dependable Bundyweld . . . and get oil lines that are extra-strong — leakproof and trouble-free.



Hydraulic lines for power steering and brake units face high pressures, constant vibration. Fabricate them from Bundyweld, and they'll deliver years of dependable, foolproof service.

There's no real substitute for

BUNDYWELD® TUBING

Bundy Tubing Distributors and Representatives: ***Massachusetts:*** Austin-Hastings Co., Inc., 226 Binney Street, Cambridge 42 • ***New Jersey:*** Atlantic Tube & Metals, Inc., P.O. Box 595, Mountain View • ***Pennsylvania:*** Rutan & Co., 1 Bala Ave., Bala-Cynwyd • ***Midwest:*** Lapham-Hickey Steel Corp., 3333 W. 47th Place, Chicago 32, Ill. ***South:*** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg., Chattanooga 2, Tenn. • ***Southwest:*** Vinson Steel & Aluminum Co., 4606 Singleton Blvd., Dallas, Texas ***Northwest:*** Eagle Metals Co., 4755 First Avenue, South Seattle 4, Wash. • ***Far West:*** Pacific Metals Co., Ltd., 2187 S. Garfield, Los Angeles 22, Calif.; Pacific Metals Co., Ltd., 1900 Third Street, San Francisco 7, Calif.

Bundyweld nickel and Monel tubing are sold by distributors of nickel and nickel alloys in principal cities.



Johnson
Ledaloyl Powder Metallurgy

Bronze or Iron
Bearings... Bushings... Parts
Offer Many Important Savings

Pre-Lubrication—The porous structure of Johnson Ledaloyl acts as a reservoir for the lubricant, providing sufficient oil during operation . . . storing it when at rest. This feature often eliminates costly lubricating devices and systems, guards against neglect and assures longer operating life of the unit.

Formed to size—The manufacturing process of Johnson Ledaloyl is essentially a forming and sintering operation. This eliminates machining, prevents scrap, yet provides accuracy at a low unit cost. Uniformity of each bearing, or part, cuts assembly time to a minimum. These are but two of the many money-saving features of Johnson Ledaloyl bearings, bushings, and structural parts. Let us show you how to design your product to take full advantage of this economy yet gain greater performance and longer service life. No obligation of course. Write for literature today.

This literature free upon request.



Johnson Bronze

675 South Mill Street • New Castle, Pa.

JOHNSON Bearings

Perpetual Emotion

Nothing so excites the American public as the annual introduction of the new model cars. And with good reason. For each year the automotive industry achieves noteworthy advances in styling, performance, comfort and safety. And that's what keeps this perpetual emotion going.

Borg-Warner is proud of its long and close association with the industry . . . proud of its hand-in-hand working relationship with automotive engineers. You see the result in every B-W automotive product—the "design it better—make it better" approach that means still better cars to come.

Whenever you need Borg-Warner's special skills and experience in automotive components, consult our engineers without obligation.



DESIGN IT BETTER ENGINEERING B-W PRODUCTION® *MAKE IT BETTER*

BORG-WARNER®

310 SOUTH MICHIGAN AVENUE • CHICAGO 4, ILLINOIS



Retards wheel spin in snow, ice, mud, sand or gravel



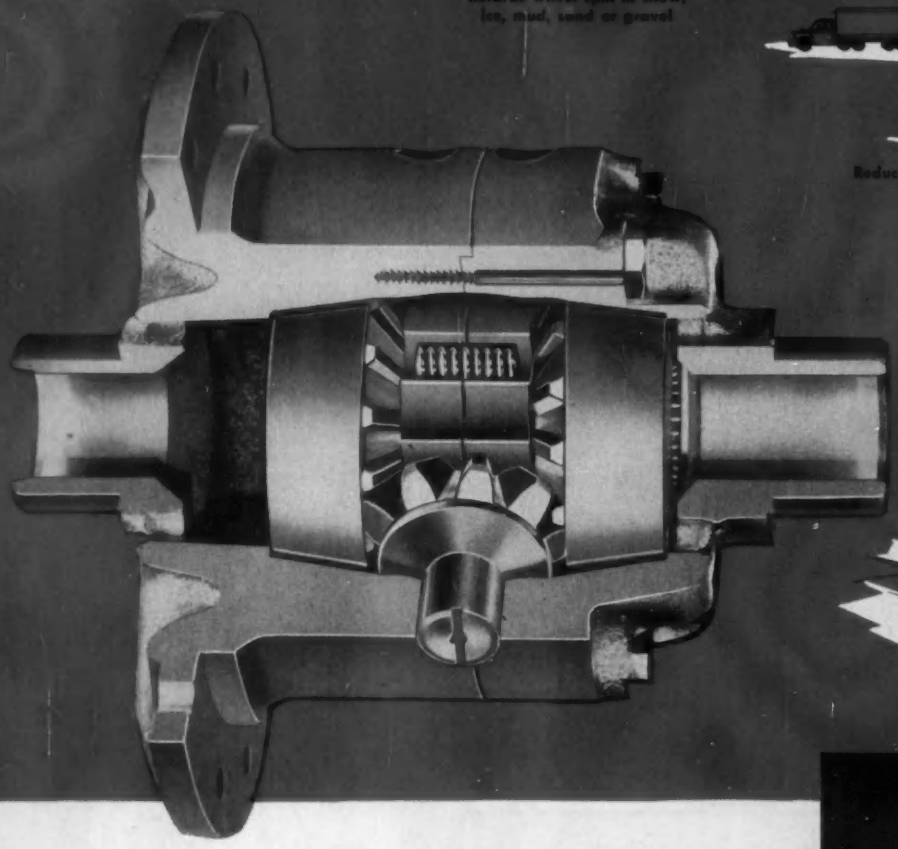
Reduces skidding on curves



Ends tire scuffing from wheel bounce



Reduces swerving on rough and high crowned roads



Announcing THE BORG-WARNER SPIN-RESISTANT PRE-LOADED DIFFERENTIAL

Makes all driving safer, surer, more economical for cars, trucks, tractors, lift trucks, other vehicles

This is the Borg-Warner Spin-Resistant Differential. With PRE-LOADED cone brakes and side gear thrust, it automatically provides internal resistance to overcome unequal traction at the rear wheels. Thus, *torque is smoothly transferred to the wheel with the greater traction.*

This B-W engineered unit has many advantages. *Simplicity*—fewer parts than other "locking" differentials. *Smooth operation*—in mud, snow, ice, sand, gravel or other poor traction conditions. *Pre-loading*—always provides a predetermined amount of resistance to differentiation. *Interchangeability*—with existing conventional differentials.

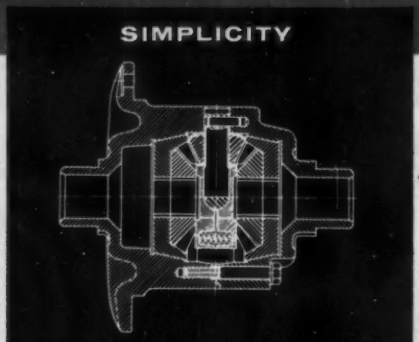
What's more, the B-W spin-resistant differential *will not* become noisy, *will not* develop excessive blacklash with wear, *will not* cause full locking of either axle shaft, *will not* interfere with normal steering.

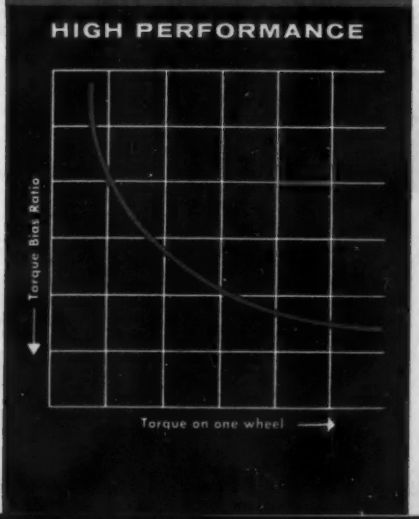
For full details, write, wire or telephone

WARNER AUTOMOTIVE DIVISION

BORG-WARNER CORPORATION • AUBURN, INDIANA

Products of Experience





YOUR TRUCKS CAN HAUL HEAVIER LOADS



with NEW BORG & BECK A8 and A9 CLUTCHES

NEW THREE-LEVER DESIGN

LIGHTER WEIGHT—SHALLOWER

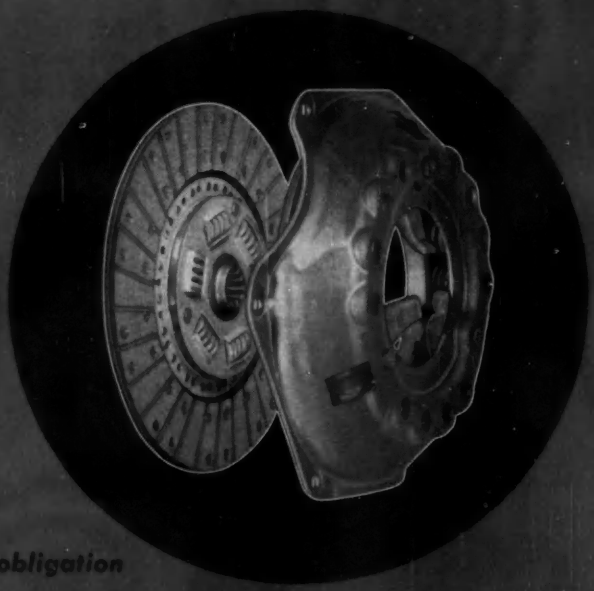
ARCH TYPE CONSTRUCTION FOR PROPER VENTILATION

SIZES TO 11"—FOR ALL BUT THE LARGEST TRUCKS

SMOOTHER, QUIETER OPERATION

EASIER ADJUSTMENT FOR MINIMUM MAINTENANCE

PRECISION BUILT—TESTED FOR BALANCE, UNIFORMITY



Consult our engineers—no obligation

BORG & BECK CLUTCH · THE STANDARD ·

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BORG & BECK®

The automotive standard for more than 40 years

for that vital spot where power takes hold of the load!

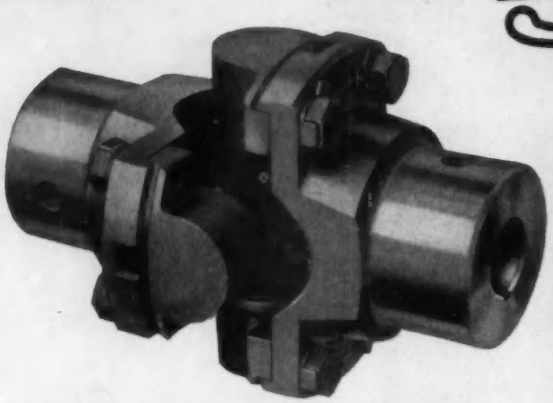
Export sales:
Borg-Warner International • 36 South Wabash Ave., Chicago 3, Illinois

BW

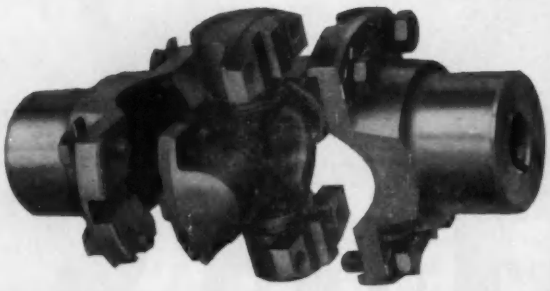
BORG & BECK DIVISION

BORG-WARNER CORPORATION • CHICAGO 38, ILLINOIS

Designers



Many of the key men who make MECHANICS joints have been doing so for over a quarter century. They know how to make MECHANICS JOINTS—from metal formula to final assembly—so the joints will serve better and longer than any "chinese copy". If you want the universal joints in *your* product to have ALL of the advantages of MECHANICS JOINTS—Compact Design, Key Drive, Better Balance, Less Weight, Fewer Parts, Easier Assembly and Quicker Servicing—specify MECHANICS and be sure of getting the genuine. Our engineers will welcome the opportunity to help you design MECHANICS' competitive sales and service features into *your* product's transmission train.



When You Specify

MECHANICS

You Get the Benefit

of Over 25 Years of

Development Know-How

From the Originators

of the Key-Drive

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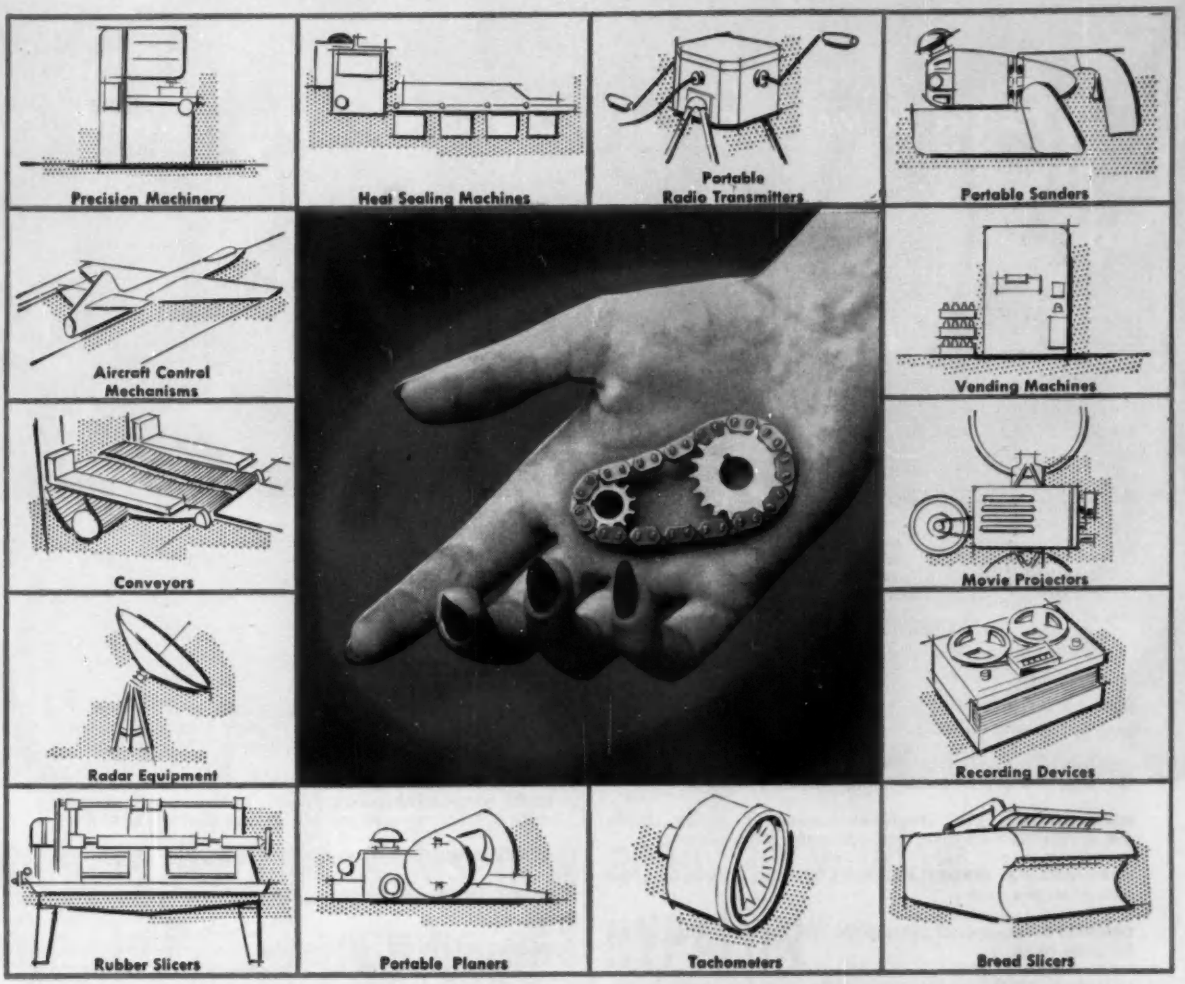
JOINT

BW

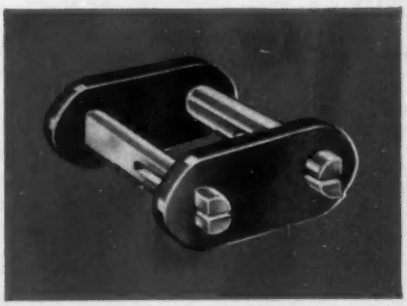
MECHANICS UNIVERSAL JOINT DIVISION

Borg-Warner • 2022 Harrison Ave., Rockford, Ill.

Export Sales: Borg-Warner International
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MORSE'S TINIEST CHAIN GIVES POSITIVE DRIVES UP TO 10,000 RPM . . . AND IN LIMITED SPACE!



EXCLUSIVE!

Patented coupling link makes assembly and removal of Morse 3/16"-pitch Silent Chain easy, permits design of fixed center drives without assembly problems. Your Morse distributor can supply you with exact lengths needed; or you can buy chain in bulk, cut it to size, assemble it yourself with easy-on coupling links.

Trying to get more components into less space? Morse 3/16"-pitch Silent Chain helps you do it—often saves you money, too!

Tiny, but with the strength of steel, these highly efficient drives transmit power as smoothly as a belt at speeds up to 10,000 rpm. Split-second precision of drive frequently permits replacement of costly gears.

You can get Morse 3/16"-pitch Silent Chain in every standard style: shroud, center guide, or duplex; special chain materials are available for use in corrosive or extremely wearing conditions. For skilled engineering help on power transmission in limited space, call your local Morse distributor today. He's listed in the Yellow Pages under "Power Transmission." Or write: *MORSE CHAIN COMPANY, DEPARTMENT 12-28, ITHACA, NEW YORK; Export Sales: Borg-Warner International, Chicago 3, Illinois.*

IN POWER TRANSMISSION
THE TOUGH JOBS COME TO

MORSE MORSE BW

*Trademark

19 OF THE 20 MAKES OF CARS CONTAIN BORG-WARNER PRODUCTS



ENGINEERED AND PRODUCED BY THESE DIVISIONS AND SUBSIDIARIES

BORG & BECK—clutches and torque converters for passenger cars, trucks and tractors.

BORG-WARNER INTERNATIONAL—foreign operations, overseas licensing and export for all Borg-Warner products.

BORG-WARNER, LTD. (England)—automotive timing chains and sprockets, overdrives and automatic transmissions.

BORG-WARNER SERVICE PARTS—U. S. distribution of automotive service parts.

CALUMET STEEL—special automobile jack bar steel; small angles for auto seats.

FRANKLIN STEEL—special automobile jack bar steel; spring steel bumper supports; small angles for auto seats.

INGERSOLL PRODUCTS—tapered steel discs for truck wheels; automotive stampings.

INGERSOLL STEEL—automotive and tractor clutch discs; carbon electric steel for tractor clutch plates; high carbon and alloy steel sheets; stainless and stainless-clad sheets and armor plate.

LONG MANUFACTURING—clutches and radiators for passenger cars, trucks, buses and tractors; torque converters; oil coolers for the automotive industry; automotive stampings; truck, tractor and bus transmissions; tractor axles and hydraulic pumps; gears and precision parts.

LONG MANUFACTURING CO., LTD. (Canada)—clutches and radiators for passenger cars, trucks, buses and tractors; oil coolers for the automotive industry.

MARBON CHEMICAL—adhesives for bonding rubber and synthetic rubber to metal and other materials; high impact thermoplastic resins.

MARVEL-SCHEBLER PRODUCTS—carburetors for military and industrial equipment and farm tractors; LPG carburetion systems; automatic transmissions; fuel injection systems.

MECHANICS UNIVERSAL JOINT—universal joints and propeller shafts for passenger cars, trucks, buses, aircraft, farm machinery, tractors, road machinery and mining machinery.

MORSE CHAIN CO.—automotive timing chains and sprockets.

MORSE CHAIN OF CANADA, LTD.—automotive timing chains and sprockets.

ROCKFORD CLUTCH—spring-loaded and over-center clutches for automobiles, trucks, tractors, road-building, earth-moving and oil field machinery, industrial machinery, agricultural implements, machine tools (Pullmore). Power take-off and gear reduction units for gasoline and diesel engines.

SPRING DIVISION—torque converter parts and sub-assemblies; sprag type free wheeling clutches; special clutch plates and parts for automatic transmissions; precision flat and Belleville type springs; multislide and punch press stampings, plain and heat treated; special commercial heat treating; small electric motor commutators.

WARNER AUTOMOTIVE—gear boxes; transmission gears; ring gears and pinions; spin-resistant differentials; differential parts and assemblies; splined shafts; power train assemblies; automotive replacement parts.

WARNER GEAR—automotive transmissions, overdrives, automatic transmissions, synchronizer assemblies, parking brakes, automotive and aircraft gears.

WARNER GEAR CO., LTD. (Canada)—synchronizer units for passenger cars and trucks.

YORK—refrigeration for trucks.

DESIGN IT BETTER ENGINEERING B-W PRODUCTION ® *MAKE IT BETTER*

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310 SOUTH MICHIGAN AVENUE • CHICAGO 4, ILLINOIS



Cutaway section of Douglas Aircraft acoustic window used on the DC-7 below. The noise barrier is an acrylic pane (A) mounted in a foam rubber damper (B). Damper is retained in a metal pan (C). A flexible HYPALON seal (D) is compressed between the inner pane and the double thickness outer window (E). A neoprene seal (F) is cemented to the metal retainer.

Douglas Aircraft seals new acoustic window with Du Pont neoprene and HYPALON®

Douglas Aircraft has developed an improved acoustic window, designed for pressurized aircraft cabins. It is now in use on the DC-7, and a similar design will be used on the new jet DC-8. To meet the rigid demands of flight conditions, two Du Pont elastomers – neoprene and HYPALON – were selected to seal the window.

The flexible seal between the noise barrier and double pane (see D in diagram) required a resilient material with complete resistance to ozone, high color stability and low temperature flexibility without the use of a plasticizer. (Plasticizers become volatile at low pressures found at high altitudes and condense on the window panes.)

Douglas engineers chose HYPALON because it was the only elastomer to meet these specifications. HYPALON has complete resistance to ozone. Unlike most rubbers, it can be compounded in a wide range of stable colors without sacrificing its other properties. This versatile synthetic rubber resists hardening at extreme temperatures (250° F.-350° F.) and retains its flexibility at temperatures as low as –40° F. without the use of a plasticizer.

Neoprene was chosen for the inner seal (F in diagram) because of its high resistance to ozone cracking. It retains its resilient properties in the face of heat, flexing, weather and sunlight. Neoprene is resistant to oil, chemicals, abrasion and cutting . . . and will not support combustion.

Investigate the design possibilities of Du Pont neoprene and HYPALON. Neoprene is currently used in aircraft fuel line connectors, heating system hose and cable jacketing. HYPALON is used in molded and extruded parts, fabric coating and convertible tops. For more information on the uses and properties of neoprene and HYPALON, just clip the coupon below.

HYPALON *is a registered trademark of E. I. du Pont de Nemours & Co. (Inc.)*

ELASTOMERS IN ACTION HYPALON® • NEOPRENE



DU PONT

Better Things for Better Living
. . . through Chemistry

☐ I am particularly interested in _____

☐ Send me a free copy of *The Du Pont Elastomers* (a review of properties of neoprene and HYPALON).

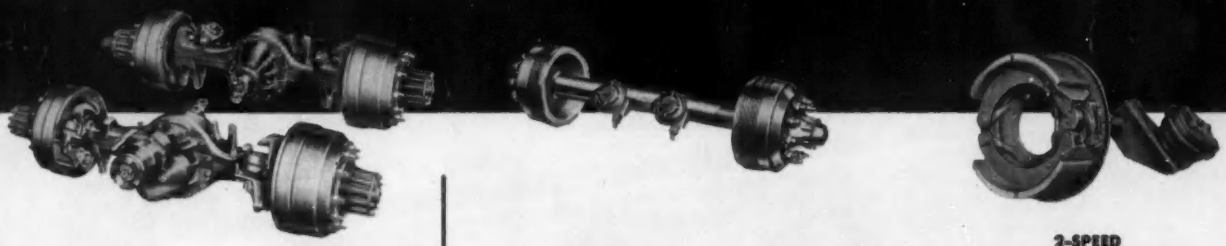
☐ Add my name to the free mailing list of the *Elastomers Notebook* (contains articles based on uses of Du Pont elastomers in industry).

E. I. du Pont de Nemours & Co. (Inc.)
Elastomer Chemicals Dept. SAE-2
Wilmington 98, Delaware

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For Today's Most Complete Line of Quality

SPECIFY... TIMKEN-DETROIT®



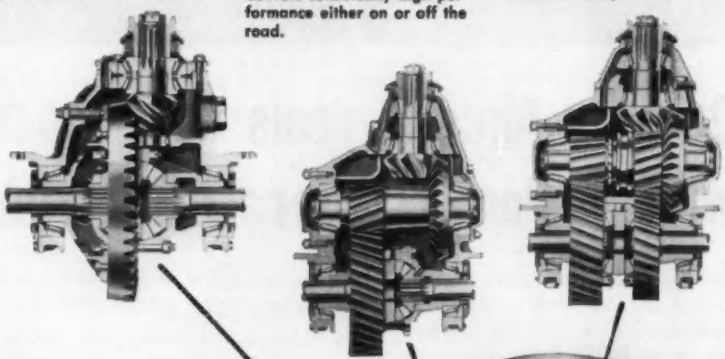
Whatever your requirements for highway or off-the-road equipment—Timken-Detroit offers you a full line of driving, trailer and front axles... brakes and gear boxes... backed by over 50 years of manufacturing experience and proved by field performance and laboratory testing.

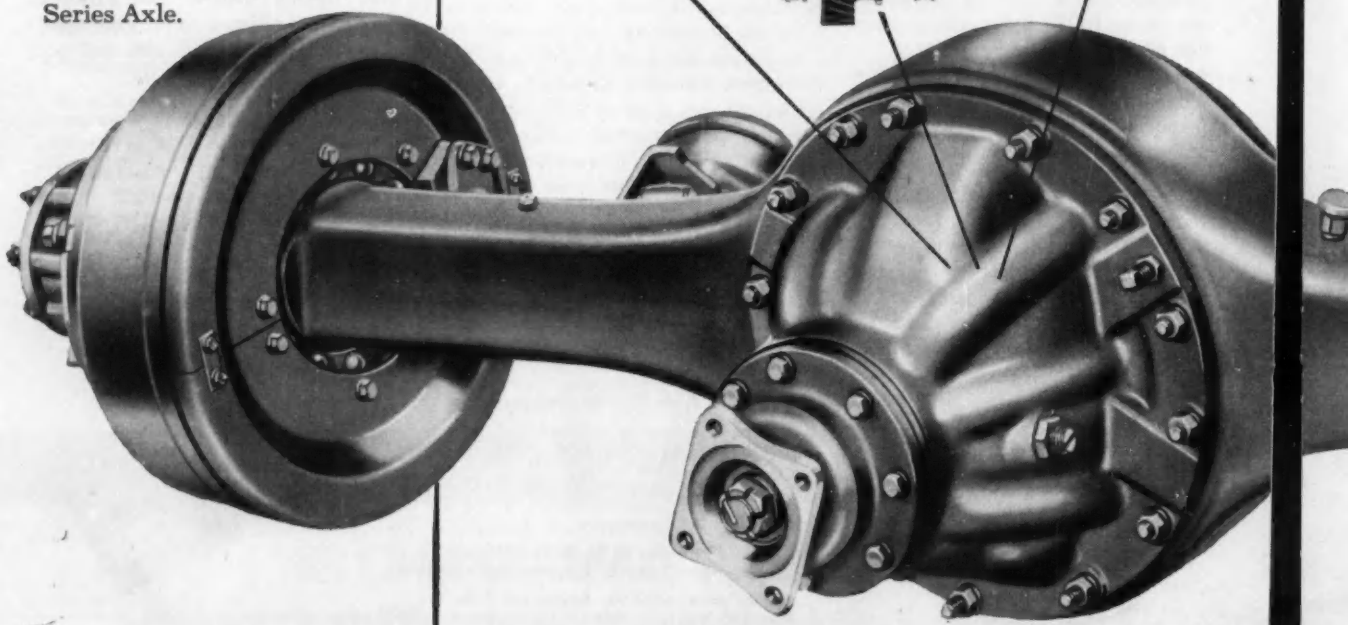
One example of the engineering features and superior quality built into *every* Timken-Detroit product is the improved "3 for 1" Letter Series Axle.

HYPOID SINGLE-REDUCTION!
A rugged single-speed power train that provides the very maximum in single reduction performance.

SINGLE-SPEED HYPOID-HELICAL DOUBLE-REDUCTION!
This advanced single-speed double-reduction final drive delivers consistently high performance either on or off the road.

2-SPEED HYPOID-HELICAL DOUBLE-REDUCTION!
This final drive gives you the most advanced two-speed double-reduction gearing available today.





WORLD'S LARGEST MANUFACTURER OF AXLES FOR TRUCKS,

Axles and Brakes for Commercial Vehicles

Products of

Rockwell Spring and Axle Co.



IMPROVED TIMKEN-DETROIT "3 FOR 1" LETTER SERIES DRIVING AXLES WILL DO THE JOB BETTER THAN EVER BEFORE!

With the "3 for 1" you gain maximum interchangeability. You have your choice of three interchangeable final drives... using the same housing, hubs, drums, brakes and axle shafts. All parts are standard production items.

Timken-Detroit "3 for 1" Letter Series Driving Axles give you longer operating life . . . lower maintenance cost ...smaller replacement parts inventory.

Check these "3 for 1" features:

Improved Hypoid Gears! Redesigned offset and increased Hypoid gear diameter provide longer gear life, smoother performance, and quieter operation.

Refined two-speed shift collar and cross shaft! Improved design gives positive locking action—reduces gear wear and maintenance. Each set of teeth performs but one function, driving or locking.

Improved torsion-flow axle shafts! More splines per shaft and increased root diameter give greater torsional strength, longer life.

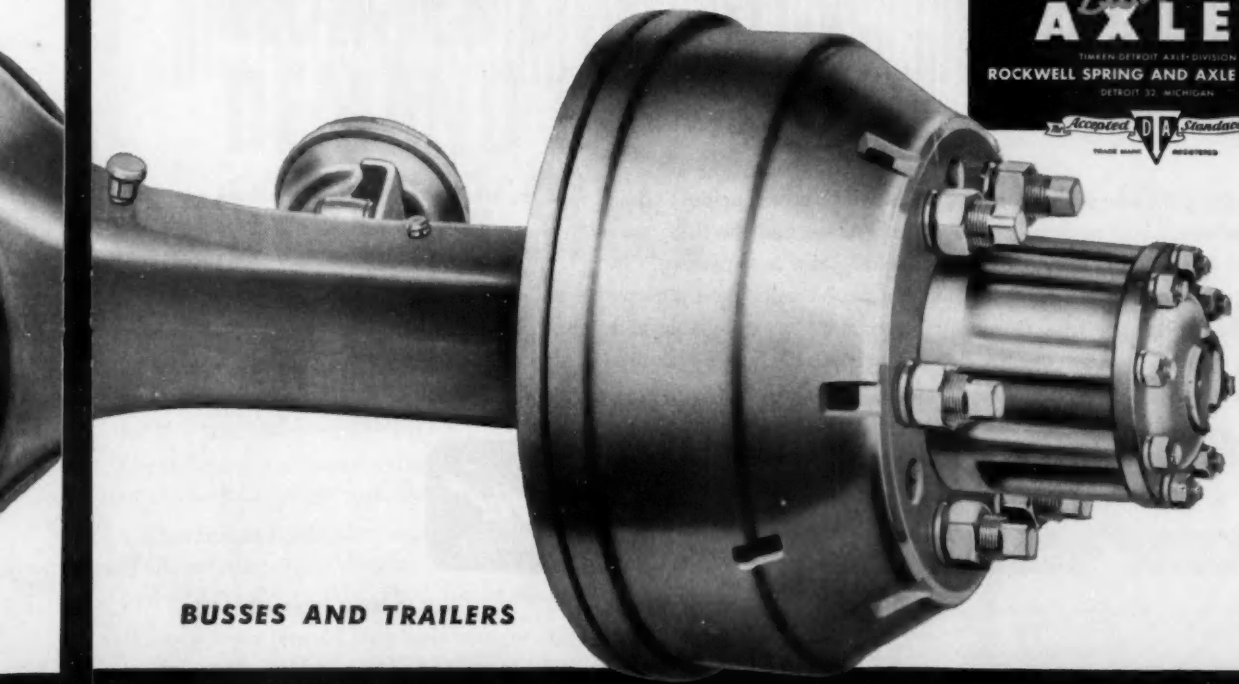
Famous time-proved differential—rugged, reliable and smooth! Extra strong gear body and teeth, plus hot-forged trunnion, give long trouble-free operation even under the roughest kind of treatment.

Hot forged steel axle housing! The rectangular form of these high-carbon steel housings is the lightest, strongest shape of housing that is available today.

Improved "P" Series Power Brakes and "DH" Series Hydraulic Brakes! Available in a complete range of sizes, these advanced brakes offer the most dependable stopping power—lower maintenance cost—easy adjustment and longer service.

Plants at: Detroit, Michigan
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DETROIT 32, MICHIGAN
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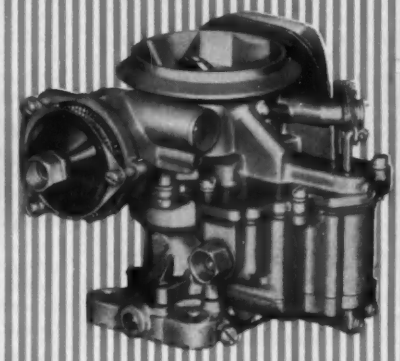


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Foremost in economy and dependability

STROMBERG



Owner loyalty is the one priceless asset without which no car manufacturer can long survive. Loyal owners become *repeat customers* and the thing that brings them back to the same dealer, year after year, is *performance*. No single component of a car is a bigger factor in performance than the carburetor. That's why it's wise to specify Stromberg*, most reliable and economical carburetor built. The Stromberg Carburetor is built by Bendix-Elmira, first name in automotive fuel systems.

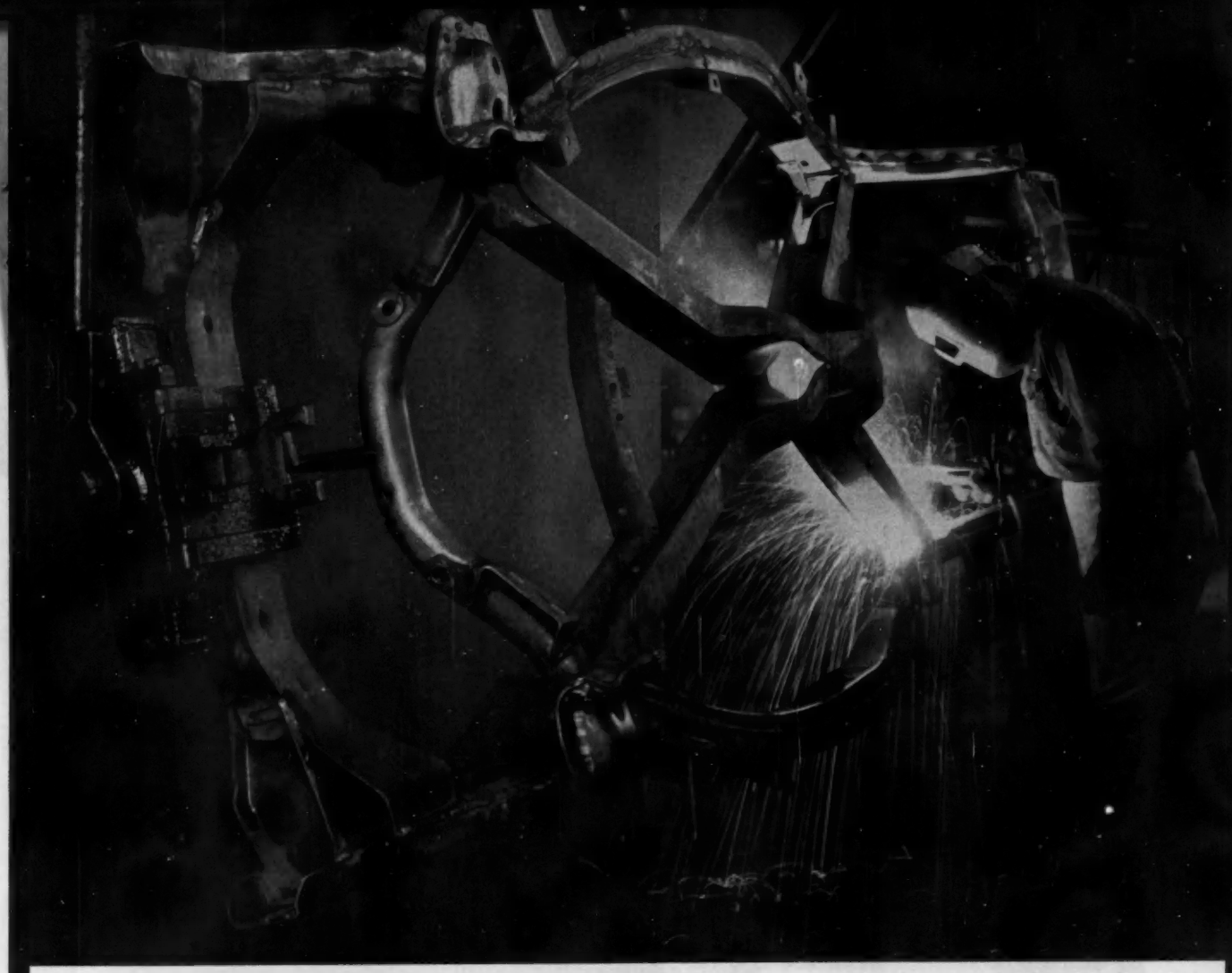
*REG. U. S. PAT. OFF.

HERE'S HOW STROMBERG OUTPERFORMS THEM ALL

- Economical operation, more miles per gallon, happier customers
- Fewer moving parts, fewer mechanical failures, reduced service cost
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- Thin aluminum throttle body and flange for quicker heat transfer

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ECLIPSE MACHINE DIVISION

Bendix
AVIATION CORPORATION



FRAMES LIKE THIS DEMAND A STRONG STEEL

At this point an automobile frame is near completion. The X-member is being welded.

Automobile frames, like so many products, are only as strong as the steel that goes into them. Automotive manufacturers and other customers have long relied on Great Lakes steel for strength and dependability.

Great Lakes quality-controlled steel provides a safe margin of strength, assuring customers satisfaction in this respect.

Uniformity and ductility are other important characteristics of Great Lakes steel. All combine to bring to you dependable performance during fabrication and in the end product.

When you get Great Lakes steel you get steel that fits your specifications, delivered on time. For the full story of Great Lakes quality-controlled steel, make it a point to call your Great Lakes Steel representative soon. He's as near to you as your telephone.

GREAT LAKES STEEL CORPORATION

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new team! in LP-Gas Carburetion...



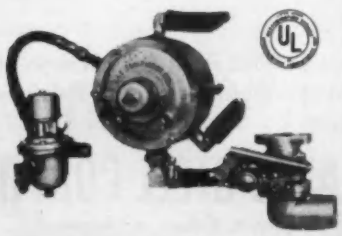
CENTURY

Marvel·Schebler

Follow the lead of 10 big manufacturers who changed to Century LP-Gas carburetion.

Century leadership is evidenced by the fact that 10 manufacturers are now installing Century LP-Gas carburetion as factory standard.

The big difference in Century carburetors is the metering valve which gives positive control of the gas regardless of changes in altitude, temperature or gas pressure. Century progressive jet carburetors are factory calibrated and set to the engine's performance curve. They provide easy starting, perfect idling and full power. They are available for every engine from 5 to 500 h.p.



Leader among Leaders!

A new champion in LP-Gas carburetion was born when Century joined Marvel-Schebler. Here is a combination of an outstanding carburetor design and a dependable factory carburetor service ready to furnish a balanced carburetion system exactly to your engine requirements.

Century now has the complete research and development facilities to build an LP-Gas carburetion system exactly suited to your engines. Each unit balanced in size and capacity. Each carburetor is factory calibrated and set to engine's performance curve. You get the ultimate in engine performance and dependability.

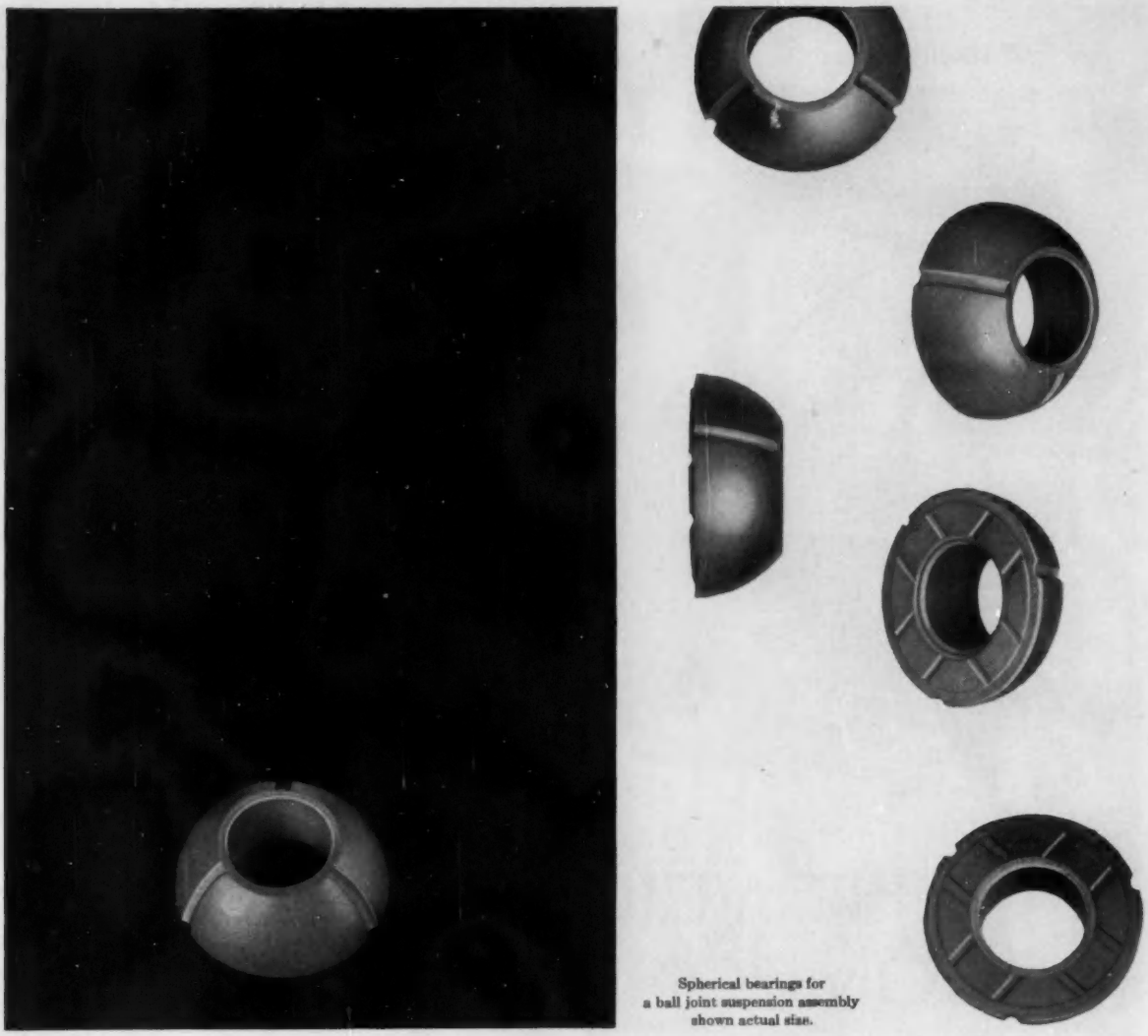
Demand the dependability of a complete Century carburetion system with metering valve control of combustion.

CENTURY

LP-GAS CARBURETION

MARVEL SCHEBLER B-W BORG-WARNER

Century Gas Equipment
Marvel-Schebler Products Division, Borg-Warner Corp.
625 Southside Drive, Decatur, Illinois



Spherical bearings for
a ball joint suspension assembly
shown actual size.

Can *complex* parts be made of sintered metals?

Yes—easily, accurately and in quantity. For example, the spherical bearings illustrated above are readily produced by Moraine from sintered metals, in quantity in one operation, without machining and to closer-than-ever tolerances. Moraine Products' advanced sintering techniques, engineering know-how, and high-capacity equipment make strong, long-lasting parts like these a routine assignment today.

Moraine Products also produces: Moraine Power Brakes • Delco Hydraulic brake fluids, brake assemblies, master cylinders, wheel cylinders, and parts • Moraine friction materials • Moraine-400 and M-100 automotive engine bearings • self-lubricating bearings and porous metal filters • rolled bronze and bi-metal bushings.

GM
FORWARD FROM FIFTY

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LIGHTWEIGHT COMPONENTS...

for HIGHLY MOBILE missile support systems

The AiResearch units shown answer the need for high-output, lightweight and compact components to be incorporated in mobile ground support systems for tactical missiles. The Gas Turbine Compressor Power Unit, proved in service, supplies shaft and pneumatic power simultaneously. DC or AC electrical current for 60, 400 or 1200 cycles can be generated for missile checkout. Gas turbine power units can be started immediately and operated under all extremes of weather.

Among the additional functions which can be accomplished with AiResearch components and systems are: main engine starting; heating and cooling for equipment and personnel; air supply for pneumatic systems including missile pre-flight de-icing, vehicle wheel drives and other linear and rotational actuation; and energizing of hydraulic systems. Reliability and compatibility are assured by components and systems now in the field. Contact the nearest Airsupply or Aero Engineering office for further information.

THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

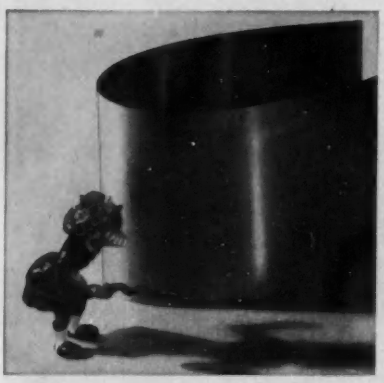
Los Angeles 45, California • Phoenix, Arizona

AERO ENGINEERING OFFICES:
MINEOLA • ATLANTA • BALTIMORE • BOSTON • CHICAGO • CINCINNATI • COLUMBUS
DETROIT • INDIANAPOLIS • PHILADELPHIA • ST. LOUIS • SYRACUSE • ORLANDO

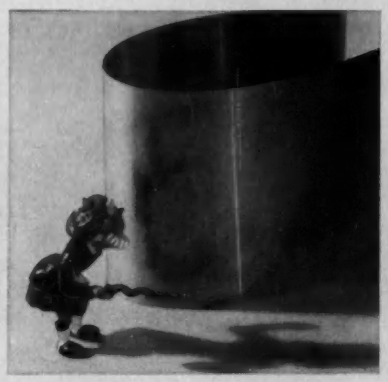
AIRSUPPLY OFFICES:
BEVERLY HILLS • DENVER • FT. WORTH • KANSAS CITY • SAN DIEGO • SAN FRANCISCO
SEATTLE • TULSA • WICHITA

No matter which FINISH you like—you can buy it in

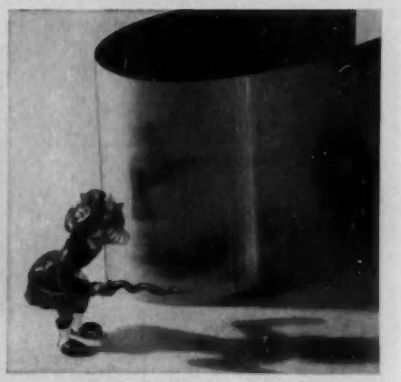
MicroRold® QUALITY STAINLESS STEEL



2D—A silvery white, but non-lustrous, surface produced by annealing and pickling cold reduced material. Steel sheets & strip in this condition are most ductile and the surface holds lubricant well for severe drawing operations.



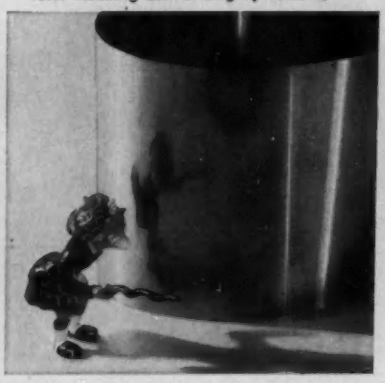
2B—Steel in the 2D condition which is subsequently rolled on a "skin pass" or temper mill. The surface acquires a bright finish from the polished rolls. This surface is somewhat more dense and hard than 2D and is a better starting surface for later finishing and buffing operations.



No. 3—This surface is made by grinding with a No. 100 abrasive. This surface is smooth but not as reflective as 2B.



No. 4—A finer finish than No. 3 made by grinding with a No. 150 abrasive. Like No. 3, this surface is easily blended with hand grinders after forming, drawing or welding.



No. 7—Good reflectivity and brilliance made by polishing with a No. 400 abrasive. This semi-mirror finish must be protected during fabrication by adhesive paper or strippable plastics lest the finish be marred beyond repair.



BRIGHT—A highly reflective surface made by cold reducing with highly polished, glass-hard rolls. This finish is only available in Type 430 stainless.

These are our standard surface finishes that are available in types 201, 202, 301, 302, 304 and 430 except Bright which is type 430 exclusively.

These finishes are regularly supplied in sheet and coil form in widths up to 48 inches.

Since Nos. 3, 4, 7 and 430 Bright are smooth reflective surfaces, they are not recommended for severe drawing without special precautions as the mill finish may be marred. Applications such as dairy machinery, kitchen and restaurant equipment and architectural decorative work require only local forming, so these highly polished surfaces are not greatly disturbed. All mill polished sheets are carefully packed to avoid handling imperfections. Protective adhesive paper can be specified by the buyer when needed.

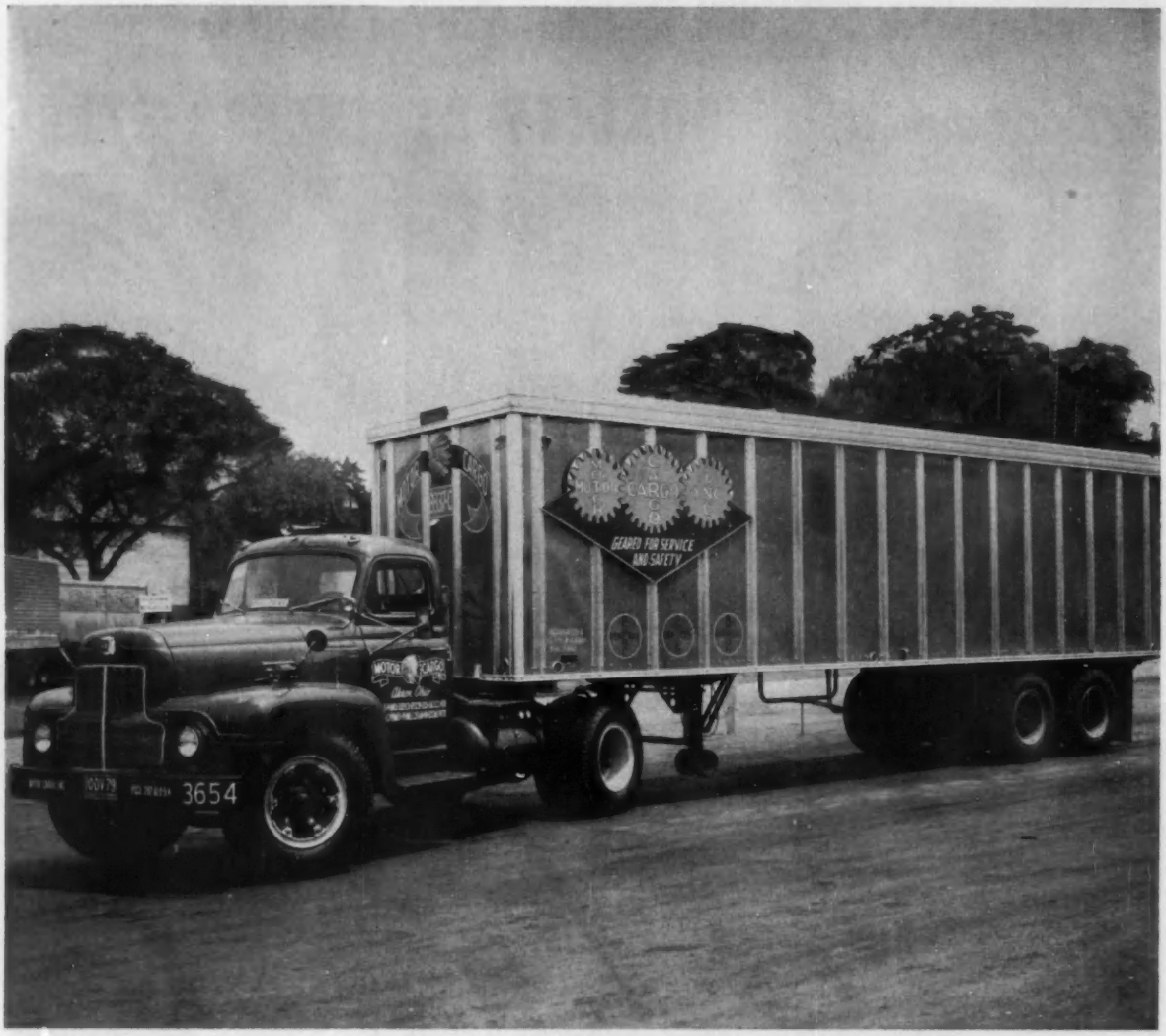
For specific information on recommended surface characteristics for a particular stainless steel sheet and strip application, address your request to our Product Development Dept.

WASHINGTON STEEL CORPORATION — MicroRold — STAINLESS — SHEET & STRIP

Washington Steel *Corporation*

Producers of Stainless Sheet and Strip Exclusively

2-K WOODLAND AVENUE, WASHINGTON, PA.



Geared by FULLER . . .

415 durable Fuller Transmissions cut Motor Cargo's maintenance costs

"The 415 Fuller 5-speed 5-A-43 Transmissions in our fleet give a long useful life of approximately 325,000 miles in 3 years, before we put them on city pick-up work for another 3 years. Maintenance cost is extremely low," says Joseph B. Boynton, Superintendent of Equipment and Garages for Motor Cargo, Inc., Akron, Ohio.

Fuller Transmissions provide not only long and satisfactory service but also they help pull the payloads through on schedule. *Right* gear ratios, smoother shifting, faster trip time, longer engine life . . . add up to greater profits for Fuller Transmission users.

Ask your truck dealer now for full details on the most efficient, easiest-shifting Fuller Transmission . . . designed with your specific job and equipment in mind.

Above: Motor Cargo rig—International Tractor is equipped with 5-A-43 Fuller Transmission.

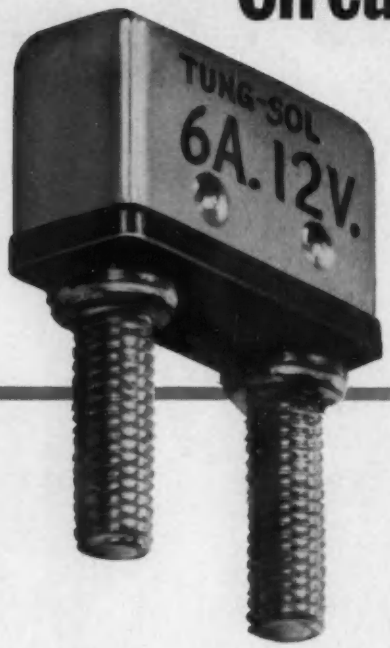
FULLER

TRANSMISSIONS

FULLER MANUFACTURING CO. Transmission Division • Kalamazoo, Mich. Unit Drop Forge Div., Milwaukee 1, Wis. • Eaton Axle Co., Louisville, Ky. (Subsidiary) • Sales & Service, All Products, West. Dist. Branch, Oakland 6, Cal. and Southwest. Dist. Office, Tulsa 3, Okla.

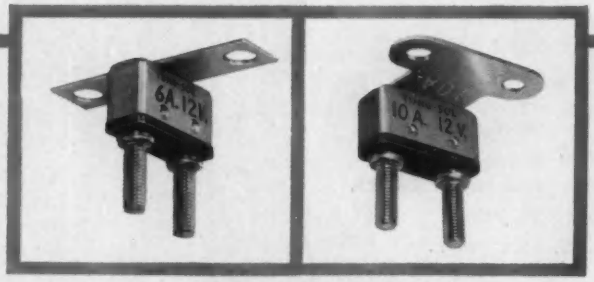

HIGH FLYING
FORGINGS
KEY TO FORGINGS SHOWN:
1. Missile Ring Splice... Aluminum – 54 lbs. 20 inches
2. Missile Rib... Titanium – 95 lbs. 98.50 inches
3. Missile Fin ... Aluminum 8 lbs. 30 inches
4. Accumulator... Aluminum – 282 lbs. 30 inches
5. Spar Fin... Aluminum – 65 lbs. 59 inches
1
2
3
4
5
In the Jet — Missile — Rocket Age, dependable forgings by Wyman-Gordon are meeting the challenge of progress. Whether for Defense or in the interest of Satellite Science, there is no substitute for Wyman-Gordon quality, experience and know-how.
WYMAN-GORDON COMPANY
Established 1883
FORGINGS OF ALUMINUM • MAGNESIUM • STEEL • TITANIUM
WORCESTER 1, MASSACHUSETTS
HARVEY, ILLINOIS • DETROIT, MICHIGAN

Tung-Sol 12-Volt Remote-Reset Circuit Breakers



Positive "Lock Open" Action gives complete protection against:

BURNED-OUT ACCESSORY MOTORS AND WIRING
PERMANENT BREAKER DAMAGE
RUN-DOWN BATTERIES



Standard Mounting Brackets

The Tung-Sol remote-reset type circuit breakers *lock open*, instead of continuing to pulsate, when the circuit is overloaded or shorted. When the cause of the overload or short is removed, the breaker is then remotely reset. It reactivates the circuit within 30 seconds.

Available in 6, 10, 15, 20, 30 and 40 amp. ratings, in a choice of two mounting brackets, Tung-Sol Remote-Reset Circuit Breakers are used in a wide variety of automotive applications. For further information write Engineering Department.

METHOD OF OPERATION

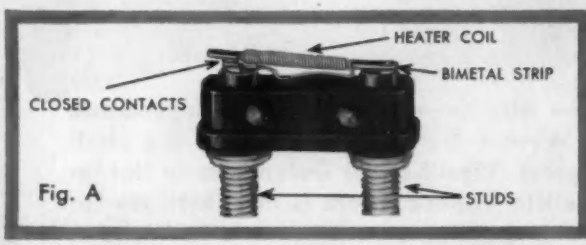


Fig. A

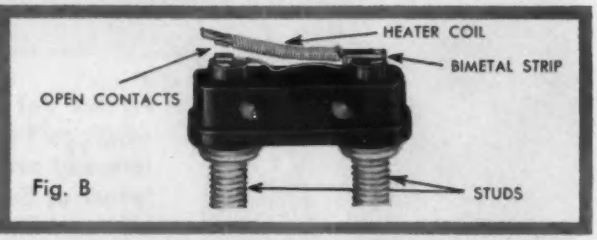


Fig. B

NORMAL CONDITIONS

When circuit conditions are normal, the current flows thru the strip which is attached across breaker studs. When contacts are closed, the heater coil is short circuited and has no heating effect. (Fig. A).

EMERGENCY CONDITIONS

When a short circuit or overload occurs, the increased current causes strip to bend away from contacts. (Fig. B). When the contacts part, the coil is automatically inserted in the circuit.

ELECTROSWITCH DIVISION TUNG-SOL ELECTRIC INC., NEWARK 4, N. J.

SALES OFFICES: ATLANTA, GA.; COLUMBUS, OHIO; CULVER CITY, CALIF.; DALLAS, TEXAS; DENVER, COLO.; DETROIT, MICH.; IRVINGTON, N. J.; MELROSE PARK, ILL.; NEWARK, N. J.; PHILADELPHIA, PA.; SEATTLE, WASH. CANADA: MONTREAL, P. Q.



up-rate horsepower

Houdaille torsional vibration damper

Untuned damper
Simple design
Longer life
Extensively tested
Completely proved
Widely adapted

Don't let torsionals restrict your engine design! Get the horsepower you want . . . without increasing engine size or crankshaft redesign. Use Houdaille Viscous Rotary Dampers. These compact *untuned* dampers offer the only truly effective way of minimizing torsional vibration across the *full range* of engine criticals.

The shearing action of highly viscous fluid, used exclusively makes it unequalled in performance.

Precision design assures long, trouble-free life. There are no rubber parts to deteriorate from heat or grease.

Typical applications include: Hydraulic servo loop system stabilization. Rotational transient stabilization. Crankshaft and camshaft torsional vibration damping.

Now available in a wide range of sizes from 1½" to 34" in diameter . . . to meet every requirement. Houdaille engineers are at your service in solving vibration damping problem.

Range of Damper Specifications:

O.D. Inches	THICKNESS Inches	FLYWHEEL INERTIA Lb. In. Sec.²	HOUSING INERTIA Lb. In. Sec.²	DAMPING CONSTANT In. Lb./ Rad./Sec.
1.625	0.750	.00023	.00003	.002
34.031	5.875	330.000	138.000	58.000

FREE TECHNICAL BULLETIN gives complete engineering and performance data. For your copy write:

Specialists in vibration control and hydraulic applications

HOUDAILLE QUALITY PRODUCTS

Houdaille Industries inc.

BUFFALO HYDRAULICS DIV. • 537 E. Delavan Ave., Buffalo 11, N. Y.

MEET THE BOLD



NEW PONTIAC

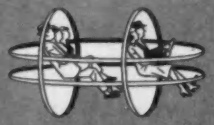
If you like to be first with the newest . . . *this is for you!*

ONLY CAR WITH . . .



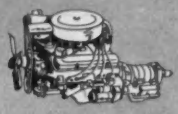
QUADRA-POISE ROADABILITY

made possible by revolutionary new frame design and suspension geometry, virtually eliminates dive, sway and bounce. Only the wheels know where the bumps are and handling's the easiest you've ever known!



CIRCLES-OF-STEEL SAFETY

Pontiac's new body surrounds you with girder steel above, below, front and rear—and floats you on rubber with no metal-to-metal contact. (Same construction in the convertible except for top.)



TEMPEST 395 PERFORMANCE

Scores of exclusive engineering innovations make Pontiac's hefty power plant a miracle of smoothness. Try its jeweled-action response in a choice of six horsepower ratings.

Never before have all these advances been teamed in any car you could own or drive! They have been brought together now in the '58 Pontiac especially to celebrate the Golden Anniversary of Pontiac and General Motors. You'll discover daring—*and wonderful*—new improvements in performance, handling, safety and comfort. And there's a long list of world-of-tomorrow options to choose from—so that you can tailor this Bold New Pontiac to your own personal specifications of the "ideal car". It's all ready for you now at your Pontiac dealer's. So, pay him a visit and make a clean break with the past.

PONTIAC MOTOR DIVISION OF GENERAL MOTORS CORPORATION



L. E. Erlewine, Supt. of Motor Maintenance WATSON BROS. says:

"We get 6000 to 8000 miles of EFFECTIVE FILTRATION from a single DIESELPAK"*

Here's powerful proof that superior performance COSTS LESS than ineffective substitutes

Only LUBER-FINER DIESELPAK, with its *exclusive* specially processed media, removes oil contaminants *effectively*—FAR LONGER THAN ANY SUBSTITUTE PACK.

DIESELPAK—designed expressly for use with H.D. detergent compounded oil—removes not only injurious suspended solids, but also colloidal impurities (often more destructive) *without affecting the additives.*

Thus LUBER-FINER DIESELPAK

1. COSTS LESS than ineffective substitutes because it gives MORE MILES of *effective filtration.*
2. Also ADDS THOUSANDS OF MILES to ENGINE AND OIL LIFE because its exclusive engineered protection CLEANS OIL FASTER AND KEEPS IT CLEAN LONGER.

STANDARD AND OPTIONAL EQUIPMENT—On leading Diesel Trucks, Tractors and Stationary Engines.

* A typical statement of many users, engineers, and original equipment manufacturers on file.

VISUAL PROOF why DIESELPAK is The Standard of the Industry

Positive end seals prevent the oil from by-passing. The oil is filtered through the patented media of the DIESELPAK which removes colloidal particles and other contaminants without adversely affecting the additives.

The oil then passes through several layers of protective fibrous material which is scientifically engineered to positively prevent media from migrating into the engine.

World renowned engineered protection is enjoyed only by the users of the genuine LUBER-FINER "DIESELPAK."



Luber-finer

WRITE FOR INFORMATION—how to get MORE MILES of effective lubrication at LESS COST. Dept. 403.

LUBER-FINER, INC.
2514 South Grand Avenue, Los Angeles 7, California

NEW

NEW

NEW

ESPECIALLY DESIGNED FOR TOP RING GROOVE PROTECTION IN PISTONS FOR GASOLINE ENGINES

AN ECONOMICAL METHOD WITH MINIMUM WEIGHT INCREASE

CAN BE APPLIED TO ANY TYPE ALUMINUM ALLOY PISTON

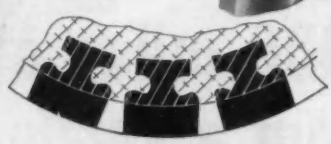


PERMA-GROOVE*

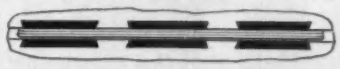
WITH SEGMENTAL STEEL TOP RING SECTION

Again, Zollner engineering leadership provides another great piston development to engine builders. The new Zollner "Perma-Groove" gives sensationally longer life to pistons and rings, prevents blow-by, minimizes oil consumption. The light weight segmental steel section incorporates high wear resistance in the top ring groove *plus* the advantage of cool operation. Designed especially for gasoline engine pistons, "Perma-Groove" is the quality, low-weight and low-cost companion to the popular "Bond-O-Loc" piston for Diesel engines. We suggest an immediate test of "Perma-Groove" advantages for your gasoline engine.

*T. M. Reg. Pat. App. For



TOP RING SECTION



FRONT VIEW SECTION



CROSS SECTION

OUTSTANDING ADVANTAGES OF ZOLLNER "PERMA-GROOVE" TOP RING SECTION

1. Individual steel segments eliminate continuous band expansion problem.
2. Segments securely locked to prevent radial movement.
3. Dovetailed edges keep steel segments securely in plane with groove.
4. 75% steel bearing area for wear resistance.
5. 25% aluminum bearing area for heat conductivity and cool operation.
6. Light in weight.

ADVANCED ENGINEERING

PRECISION PRODUCTION

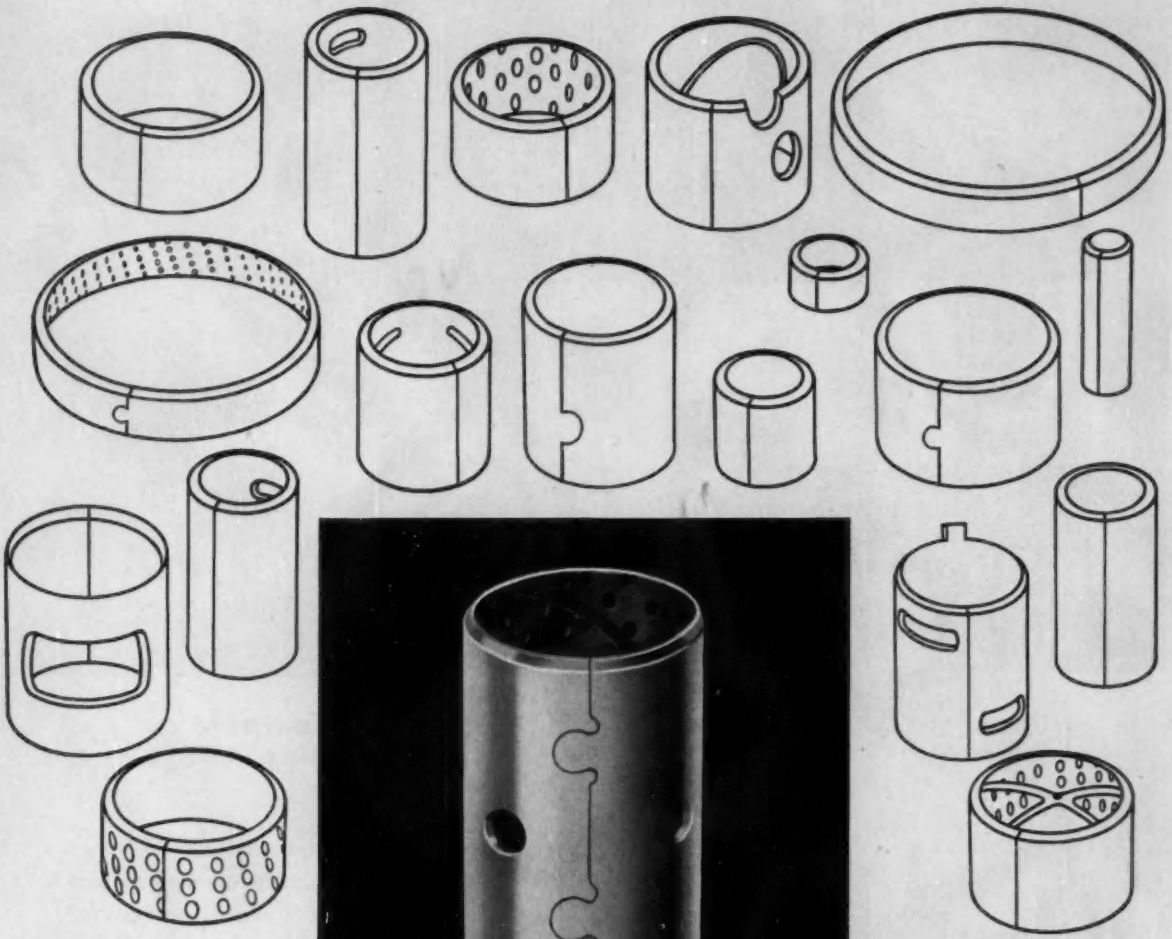
COOPERATION WITH ENGINE BUILDERS

ZOLLNER PISTONS

THE ORIGINAL EQUIPMENT PISTONS

ZOLLNER

ZOLLNER CORPORATION • Fort Wayne, Indiana



Solid bronze, steel or aluminum

Steel lined with bronze, babbitt or copper alloy

Plain or ball indented

Oil holes, grooves, slots, notches as required

Straight, clinch butt or special seams

Many lengths and diameters

Bearing Performance • Bushing Economy plus special design features

Savings in materials, time and labor are possible using bimetal or plain rolled split bushings. Bimetal bushings provide bearing load-carrying qualities. All offer economy through volume production. Uniformity and strength are established through controlled alloy quality and grain structure. Our method of manufacture also permits wide flexibility in design features. Complete engineering service. For details, address:

FEDERAL Mogul SINCE 1899

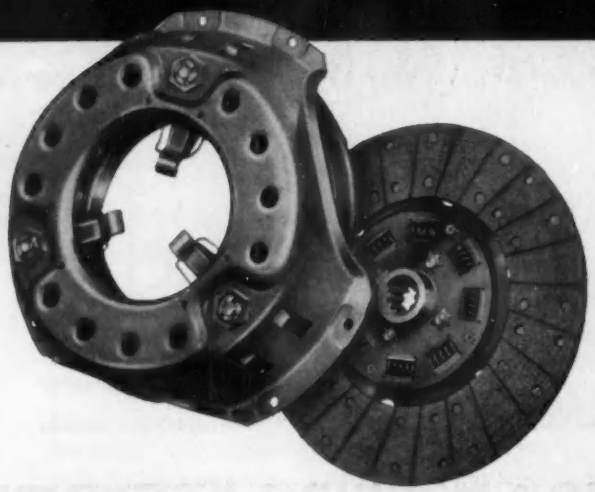
FEDERAL-MOGUL DIVISION

FEDERAL-MOGUL-BOWER BEARINGS, INC., 11035 SHOEMAKER, DETROIT 13, MICHIGAN

RESEARCH • DESIGN • METALLURGY • PRECISION MANUFACTURING

Now, a LIPE 12"

heavy-duty Direct Pressure Clutch



FIRST in the entirely new Lipe DPB Line...

featuring:

- **Maximum mechanical efficiency!**
- **Optional needle-bearing linkage!**
- **Stronger, lighter stamped cover!**
- **Full ventilation for cooler running!**
- **Fade-resisting chrome silicon springs!**
- **Spring heat-insulating washers!**
- **Lower pedal load!**
- **Competitive price!**

Here's the first in a new series of Lipe direct pressure clutches to supplement the already-famous DP Line! With the introduction of the new 12" DPB single and two plate, Lipe direct pressure clutches are available for all applications involving gross vehicle weights of 19,000 lbs. and up. Additional DPB models in 13" through 15" single and two plate sizes will be available soon.

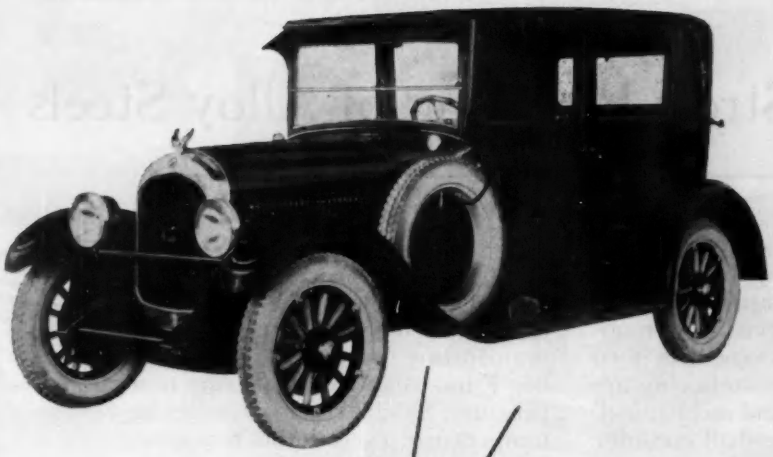
The new Lipe 12" DPB clutch is interchangeable with many other models and is easily adapted to any present vehicle requirements. Improved design, a simpler, sturdier internal lever system, and Lipe's precision manufacturing and testing assure you extra clutch mileage in your vehicles.



WRITE or WIRE for an Engineering Data Sheet on the Lipe 12" DPB—or for first-hand information request that a Lipe Field Engineer call on you at your convenience.

LIPE ROLLWAY

Lipe-ROLLWAY CORPORATION
SYRACUSE 1, N. Y.



There have been some changes made

Many things have changed in the years since the first Chrysler automobile, the 1924 *six* cylinder Brougham, was produced. Thirty-four years of constant progress in design and engineering are reflected in the 1958 model.

Purolator is proud of its association with Chrysler, which began with the first production model and has continued, through the years, right up to the 1958 line. The progress of the automotive industry has been matched by that of Purolator in engineering skills and manufacturing facilities. Purolator designed and made the first automotive oil filter . . . it was a big feature of the 1924 Chrysler . . . and has continuously designed and made the exact filters required for the specific needs of the industry. They are ready to meet future filtration requirements.



Filtration For Every Known Fluid

PUROLATOR

PRODUCTS, INC.

RAHWAY, NEW JERSEY AND TORONTO, ONTARIO, CANADA

XXV

This is the twenty-fifth of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many in this field, including men of broad experience who may find it useful to review fundamentals from time to time.

Thermal Stress-Relieving of Alloy Steels

In the production of alloy steel bars and parts made of alloy steel, stresses are sometimes set up, and these stresses must be relieved before optimum results can be expected. Two general types of stress-relieving are practiced—thermal and mechanical. In this discussion we shall consider only the former.

There are several important reasons for thermal stress-relieving. Among these are the following:

(1) The first and most fundamental purpose is to reduce residual stresses that might prove harmful in actual service. In the production of quenched and tempered alloy steel bars, machine-straightening is necessary. This induces residual stresses in varying degrees. Bars are usually stress-relieved after the straightening operation. When the bars are subjected to later processing that sets up additional stresses, subsequent stress-relieving may be necessary.

(2) A second major purpose of thermal stress-relieving is to improve the dimensional stability of parts requiring close tolerances. For example, in rough-machining, residual stresses are sometimes introduced, and these should be relieved if dimensional stability is to be assured during the finish-machining.

(3) Thermal stress-relieving is also recommended as a means of restoring mechanical properties (especially ductility) after certain types of cold-working. Moreover, it is required by the "safe-welding" grades of alloy steels after a welding operation has been completed.

Alloy bars are commonly stress-relieved in furnaces. Temperatures under the transformation range are employed, and they are usually in the area from 850 deg to 1200 deg F. The amount of time required in the furnace will vary, being influenced by grade of steel, magnitude of residual stresses caused by prior processing, and mass effect of steel being heated. After the bars have been removed from the furnace, they are allowed to cool in still air to room temperature.

In the case of quenched and tempered alloy bars, the stress-relieving temperature should be about 100 deg F less than the tempering temperature. Should the stress-relieving temperature exceed the tempering temperature, the mechanical properties will be altered.

Items other than bars (parts, for example) can be wholly or selectively stress-relieved. If the furnace method is used, the entire piece is of course subjected to the heat; selective relieving is impossible. However, if a liquid salt bath or induction heating is used, the piece can be given overall relief or selective relief, whichever is desired.

Detailed information about stress-relieving is available at all times through Bethlehem's technical staff. Feel free to consult with our metallurgists, who will cooperate fully without cost or obligation on your part. And remember that Bethlehem can furnish the entire range of AISI standard alloy steels, as well as special-analysis steels and all carbon grades.

If you would like reprints of this series of advertisements from No. I through No. XX, please write to us, addressing your request to Publications Department, Bethlehem Steel Company, Bethlehem, Pa. The first 20 subjects in the series are now available in a handy 36-page booklet, and we shall be glad to send you a free copy.

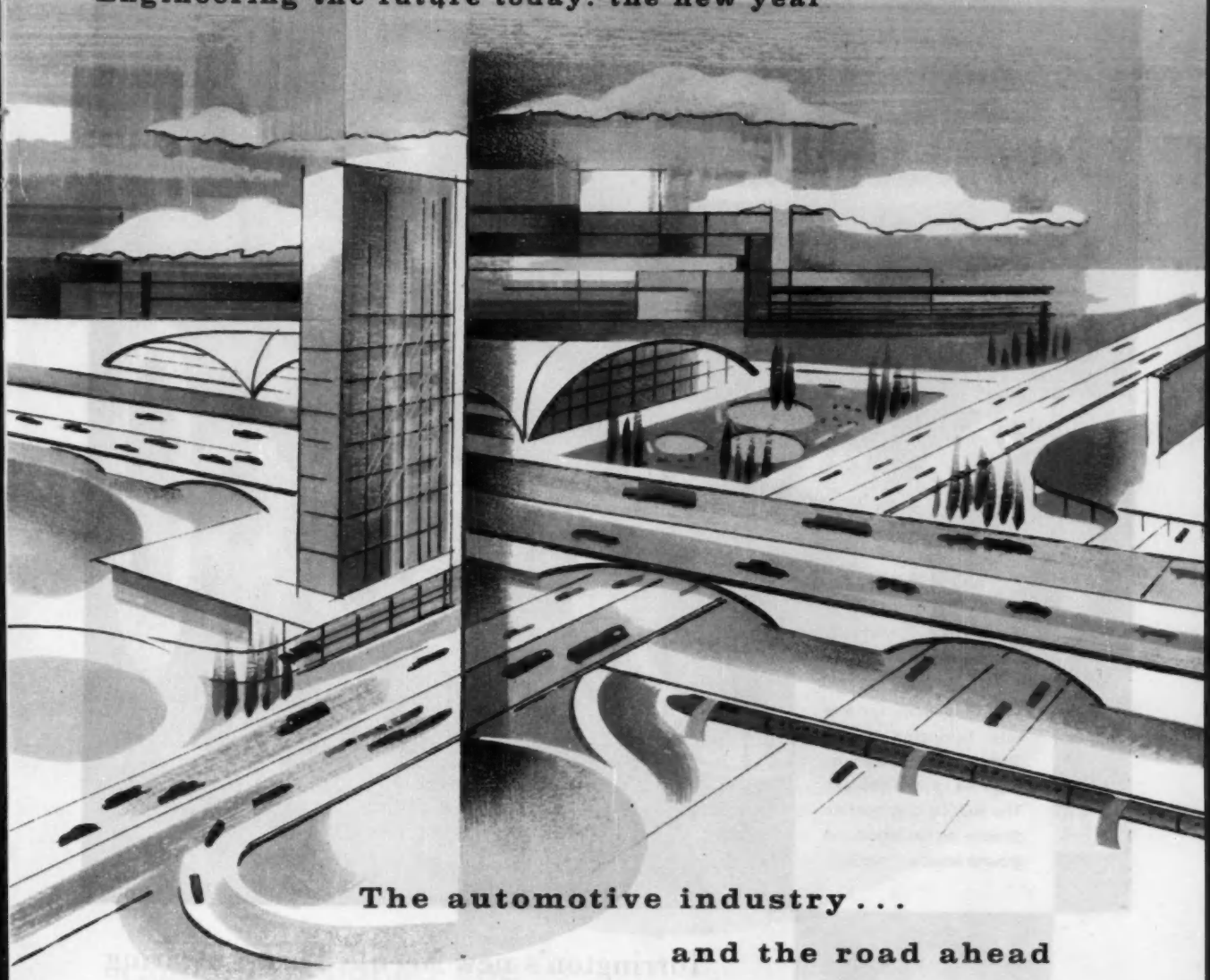
BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

Engineering the future today: the new year



The automotive industry . . .
and the road ahead

Progress comes from visions of tomorrow . . . and the vigor to take action today.

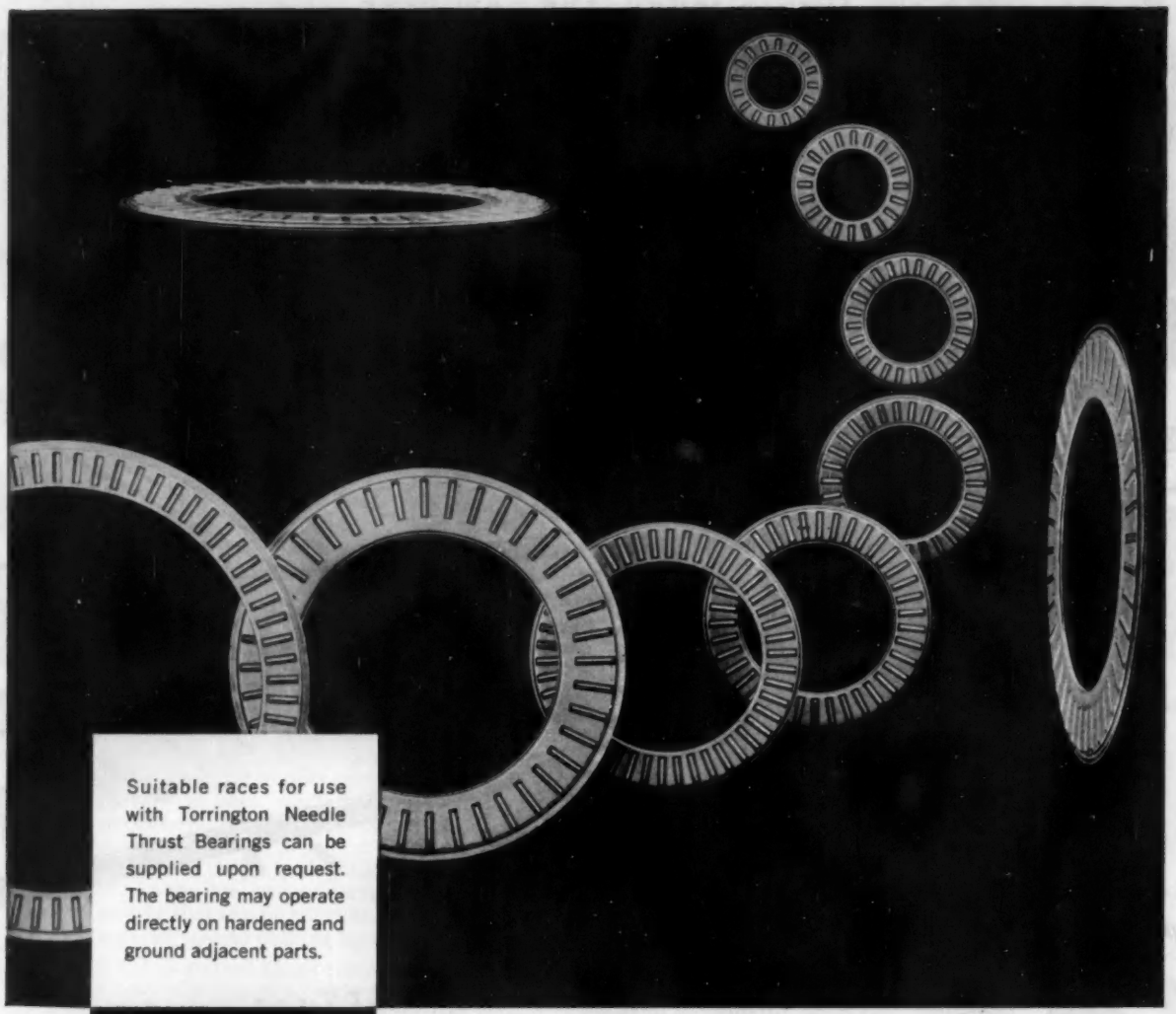
Carter's future is one with the future of the automotive industry. And we're working hard to make it bright, through expansion of manufacturing and research facilities, and new automotive fuel system developments.

Some of these developments, such as the low-line four-barrel carburetor, are already on the road. Others are now taking on the dynamic shape of progress . . . inside the busy Carter plants.

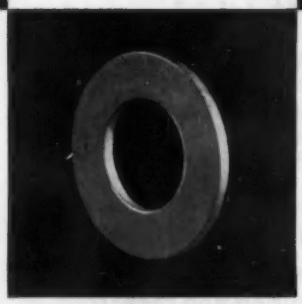
For Carter, and the automobile manufacturers it serves, the year ahead . . . and the road ahead . . . is filled with the promise of progress.

CARTER CARBURETOR

DIVISION OF ACF INDUSTRIES, INCORPORATED • SAINT LOUIS 7, MISSOURI



Suitable races for use with Torrington Needle Thrust Bearings can be supplied upon request. The bearing may operate directly on hardened and ground adjacent parts.



Torrington's new Needle Thrust Bearing grows in popularity...and range of sizes

Designers have been quick to take advantage of the compactness, high thrust capacity and low unit cost of Torrington's new Needle Thrust Bearing.

To meet the growing demand for this bearing in automatic transmissions, governors, steering gears, bevel gears, hydraulic pumps, torque converters and many other applications, tooling has been completed to produce bearings ranging from .500" ID to 3.000" ID.

Only .0781" thick, the Torrington Needle Thrust Bearing is thin as an ordinary thrust washer, yet brings all the advantages of anti-friction operation to applications where space is limited. Mating steel retainer halves are joined securely to form a self-contained unit that is easy to handle and install.

Plan today to evaluate the Torrington Needle Thrust Bearing. Services of our Engineering Department are available to help you. For full information, write for Bulletin No. 16, "Torrington Needle Thrust Bearings." *The Torrington Company*, Torrington, Conn.—and South Bend 21, Ind.

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Bet your boots we make 'em



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Whether you want a boot two stories high . . . or no bigger than your thumb . . . let C/R Sirvis engineers solve the problem for you. They're specialists . . . backed by 78 years' experience . . . with unusual skills and ingenuity in the development and manufacture of mechanical boots. They'll design and produce a C/R Sirvis boot to your exact requirements in any size, any quantity . . . using only the finest materials: mechanical leather, selected, tanned and treated by C/R . . . nylon . . . or elastomer-coated fabric. The absolute dependability of your boot will be proved before production.

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The unique design of the "load cushion" accounts for smooth, even rides in the full range of loads, empty to full. Enjay Butyl Rubber (in red) made it possible.

ENJAY BUTYL "LOAD CUSHION"

replaces steel springs in big Tractor Trailers

The "load cushion" is an important innovation in tandem suspension. Developed by the Hendrickson Mfg. Company, it is made of Enjay Butyl and replaces steel leaf springs. Utilizing the great strength and impact resistance of Enjay Butyl, the "load cushion" gives the ultimate in a soft, easy ride within the complete range of loading, from empty to full. Besides giving a smoother, steadier ride, it increases tire mileage, reduces weight and significantly reduces wear and tear on equipment.

Enjay Butyl has proved to be the answer to problems in many fields of industry. It may well be able to cut costs and improve the performance of *your* product. Low-priced and immediately available, Enjay Butyl may be obtained in non-staining grades for white and light-colored applications. Get all the facts by contacting the Enjay Company. Complete laboratory facilities and technical assistance are at your service.

ENJAY BUTYL

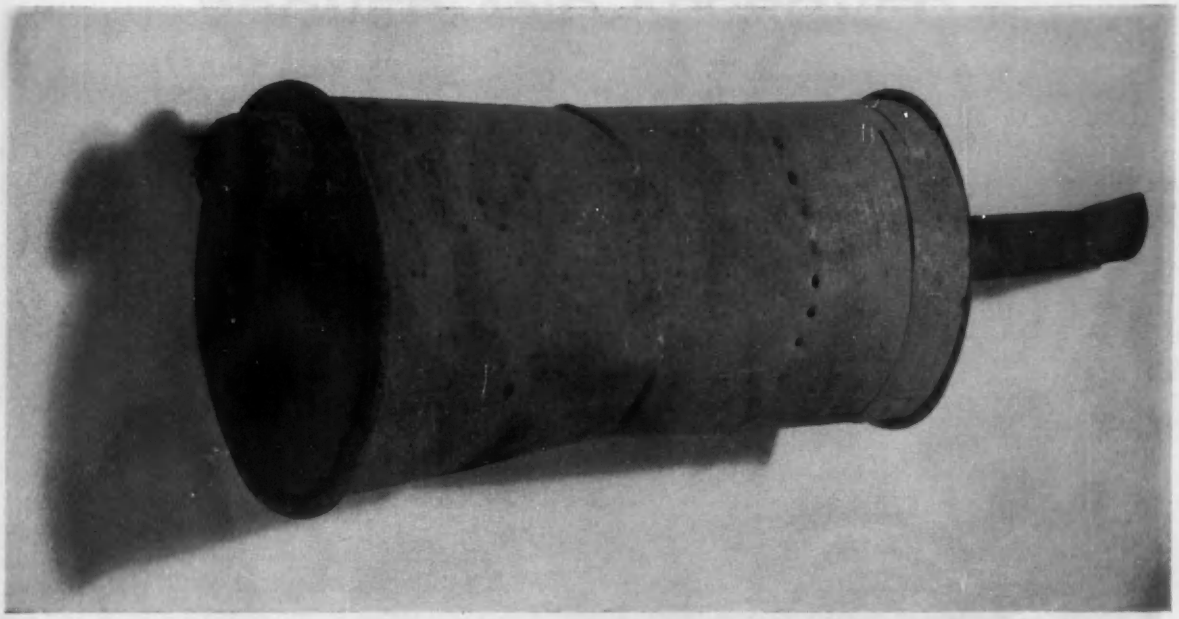
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Enjay Butyl is the super-durable rubber with *outstanding* resistance to aging • abrasion • tear • chipping • cracking • ozone and corona • chemicals • gases • heat • cold • sunlight • moisture.



This Auto Muffler Lasted 72 Months

It's Made of Armco ALUMINIZED STEEL

Six years' service life is an excellent record for any kind of muffler. This muffler is of common design. The only thing different about it is the special steel from which it's made—Armco ALUMINIZED STEEL.

Of course, car owners don't always get this kind of life, even from mufflers made of ALUMINIZED STEEL. But actual road tests show that mufflers made from this special hot-dip aluminum-coated steel average at least *twice the life* of their carbon steel counterparts.

HERE'S THE REASON

Superior resistance to combinations of heat and corrosive exhaust gases is the reason why mufflers made of Armco ALUMINIZED STEEL last so much longer. As a result, early failures are reduced. Mufflers are much more likely to span the vital first-owner period.

Here's another important fact: This remarkable steel is available at less cost than any other metal with comparable resistance to a combination of heat and corrosion.

For complete information about this economical steel for longer-lasting mufflers, just fill in and mail the coupon or phone your nearest Armco Sales Office.

Other Armco Steels for top-quality automotive products include Stainless Steels in all forms, ZINCGRIP®, ZINCGRIP PAINTGRIP®, Cold-Rolled PAINTGRIP, Long Ternes, Steel Tubing, and high-quality Hot- and Cold-Rolled sheets.

ARMCO STEEL CORPORATION, 1278 Curtis Street, Middletown, Ohio

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ARMCO STEEL

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SHEFFIELD DIVISION • ARMCO DRAINAGE & METAL PRODUCTS, INC. • THE ARMCO INTERNATIONAL CORPORATION





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sidewinder...

a deadly new fang for Naval Jets!

The Navy's new self-guided, air-to-air missile, "Sidewinder," is so accurate that it can "home" in on and hit the tailpipe of a supersonic jet engaged in violent evasive action. Control fins for this deadly new missile are produced by the Aviation Divisions of Kelsey-Hayes Co., Detroit 32, Michigan.

KELSEY-HAYES

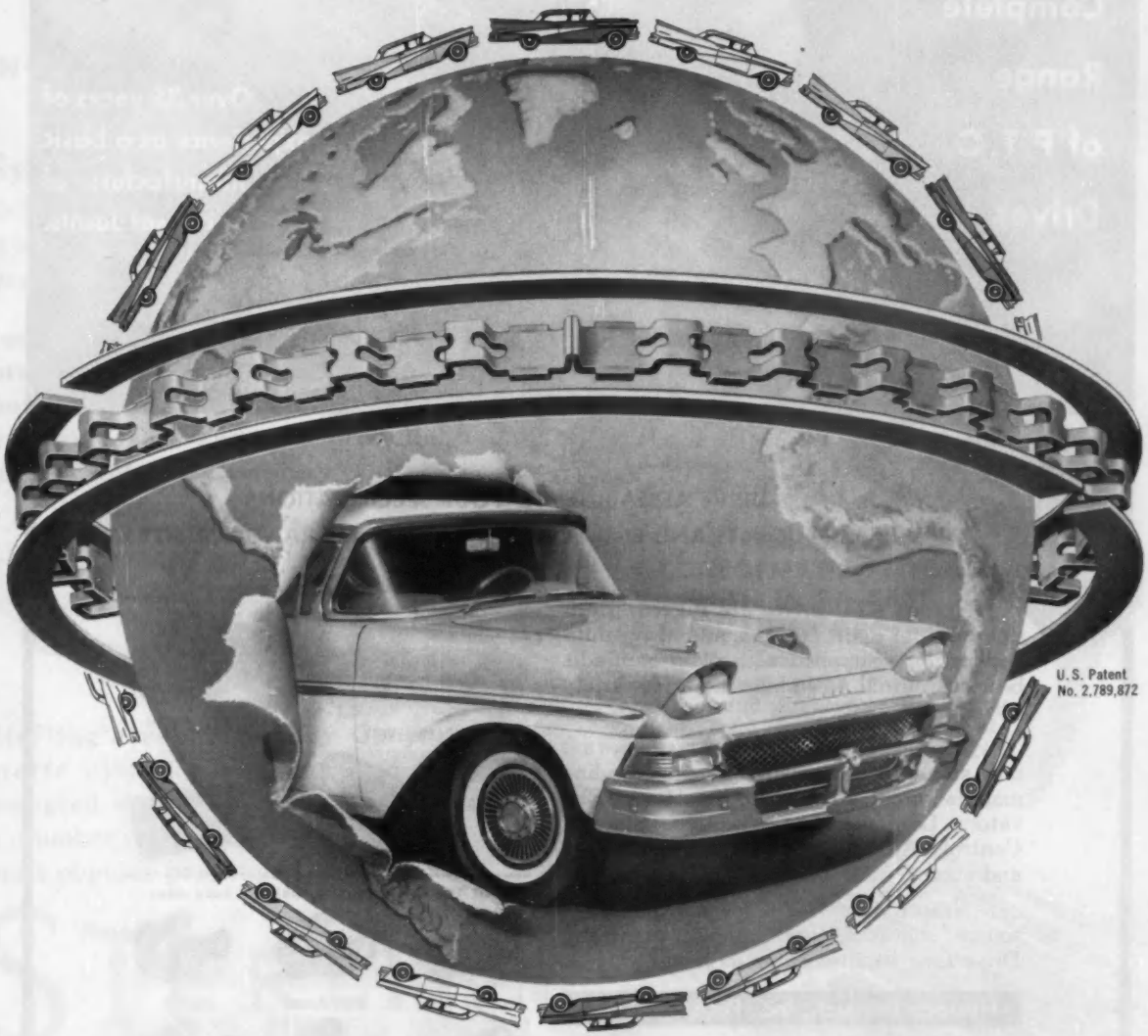
Automotive, Aviation and Agricultural Parts • Hand Tools for Industry and Home

17 PLANTS: Detroit and Jackson, Mich.; Los Angeles; McKeesport, Pa.; Springfield, Ohio (Speco Division); Utica, N. Y. (Utica Drop Forge & Tool Division); Davenport, Iowa (Farm Implement and Wheel Division); Philadelphia (Heintz Division); Windsor, Ontario, Canada.

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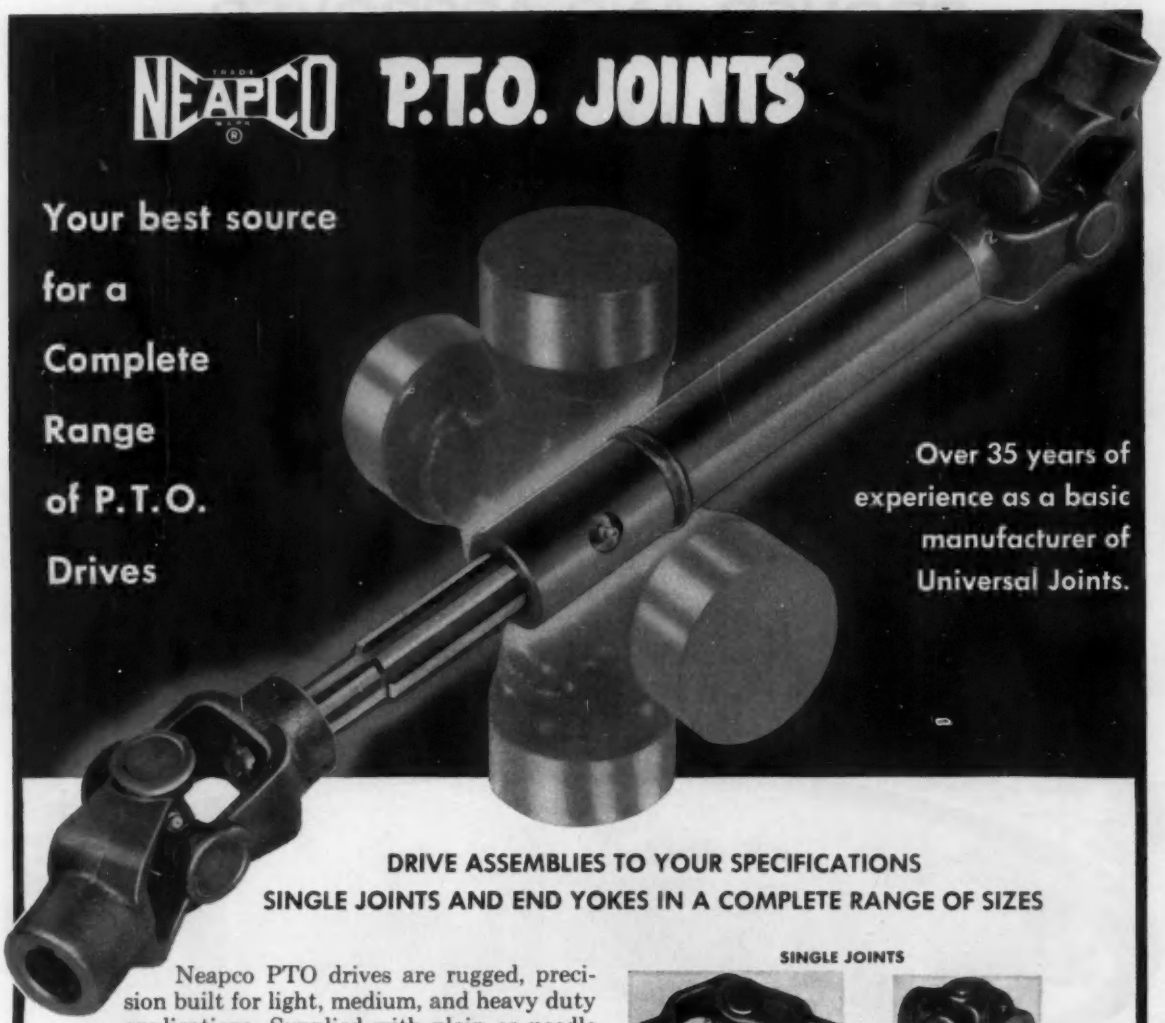
U. S. Patent No. 2,789,872

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Over 35 years of experience as a basic manufacturer of Universal Joints.

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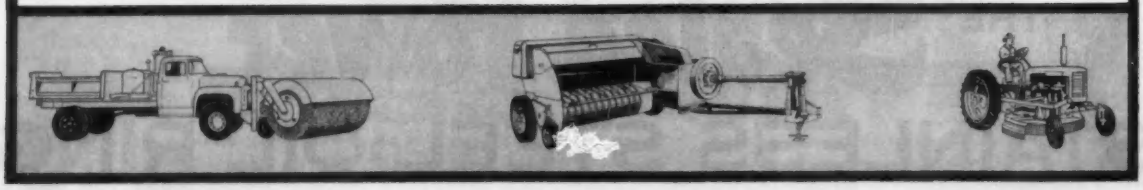
Write for free engineering literature, or send us your specifications. Neapco will also design assemblies to meet your requirements.

SINGLE JOINTS



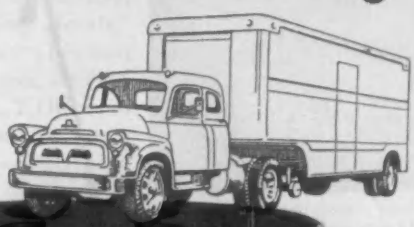
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Rapidly becoming the

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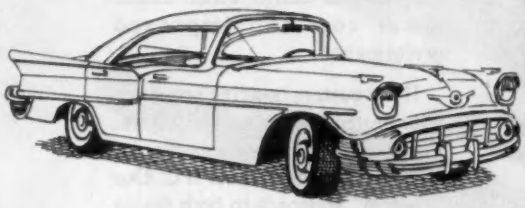
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Recommended clearances for "Conformatic" pistons are from 0 to ½ thousandth inch. This clearance is maintained hot and cold providing unbelievable bore stability.

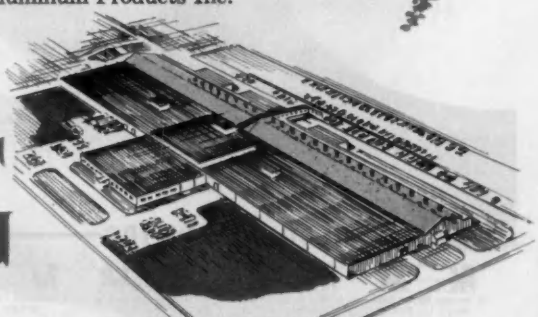


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prevents frictional horsepower loss, reduces oil consumption to an absolute minimum, and prolongs engine life up to 400%. *Intra-Cast* and *Conformatic* are registered trade names of STERLING Aluminum Products Inc.



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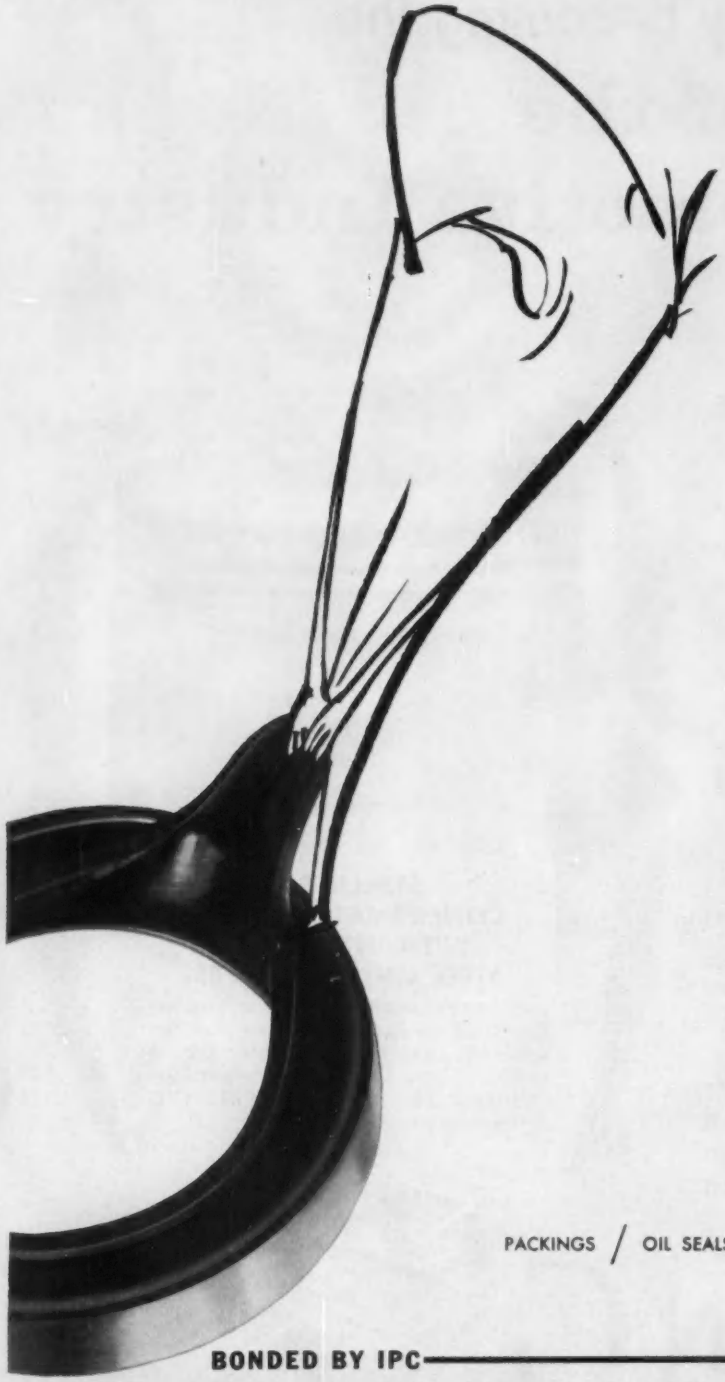
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Welding stainless steel sheet into a smooth, streamlined shape for jet plane fuel tanks is a production job for HELIARC Welding. This method, utilizing a tungsten electrode shielded by LINDE Argon, was developed by LINDE especially for use on hard-to-weld commercial metals.

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Get more information about HELIARC Welding. For a free copy of the booklet, "Modern Methods of Joining Metals," write Dept. SA2, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. Offices in other principal cities. *In Canada:* Linde Company, Division of Union Carbide Canada Limited.



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Tachometer Take-Off



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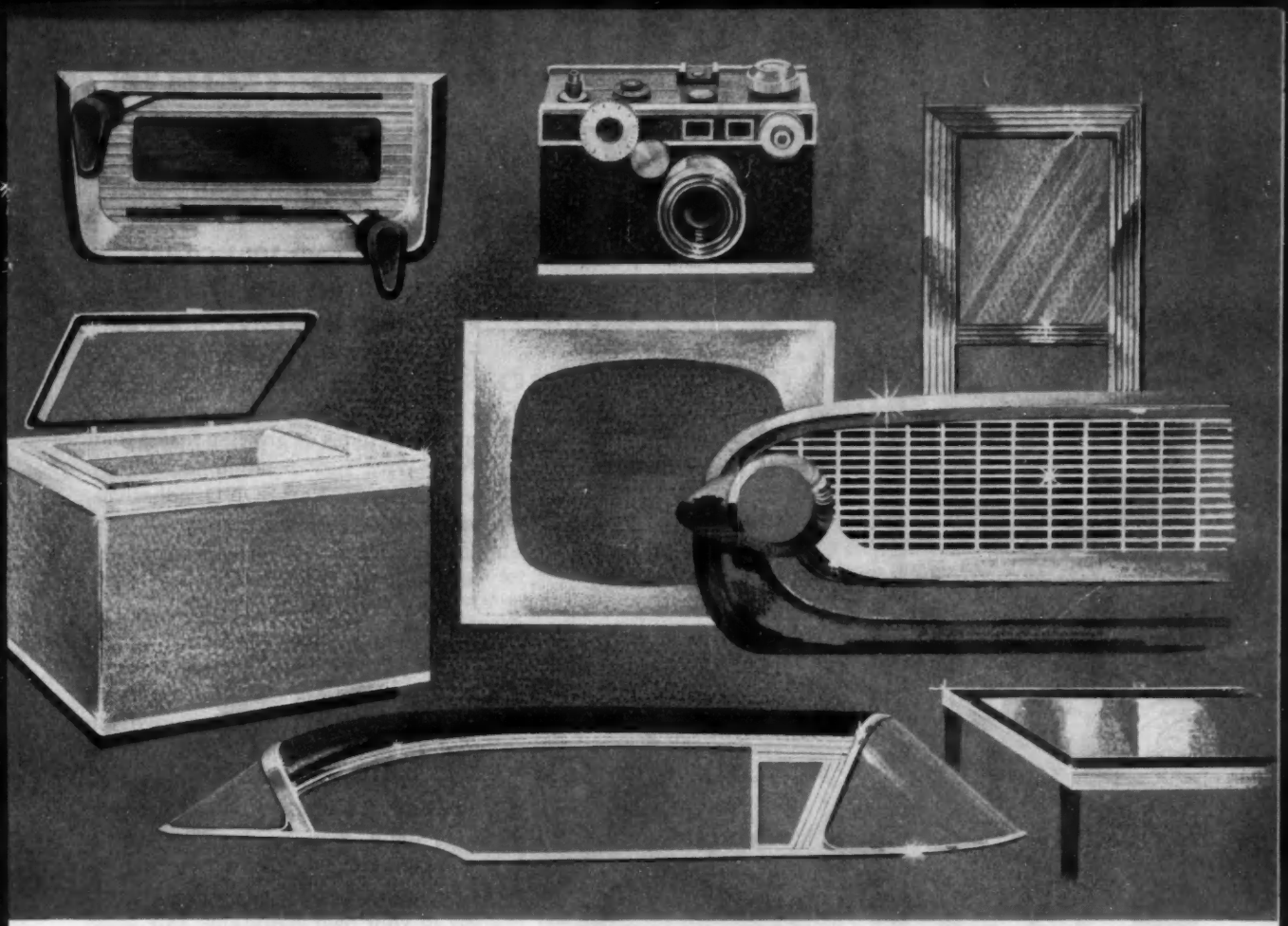
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You can count on Veeder-Root to figure out how to engineer these adaptable Rev-Counters into *your* products . . . not only engines, but generators, compressors, heaters, refrigerators, and what have you? Write:

Everyone... Can Count on

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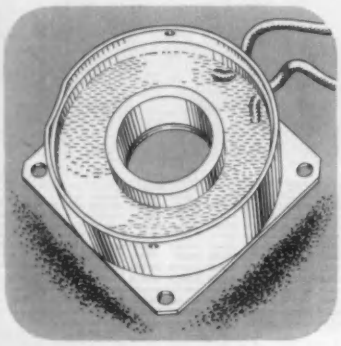
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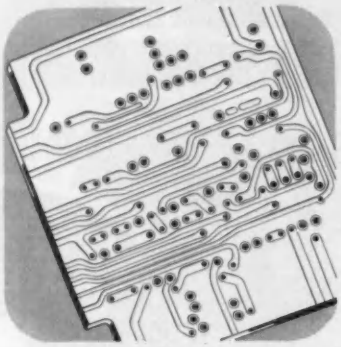
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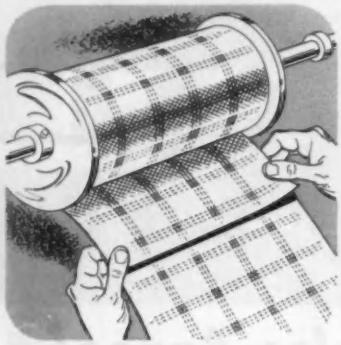
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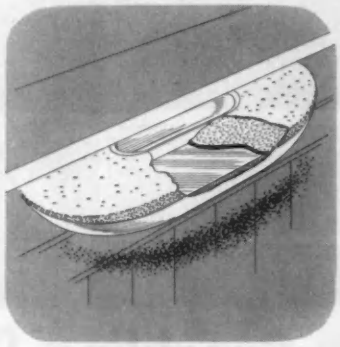
Casting compound for electrical applications



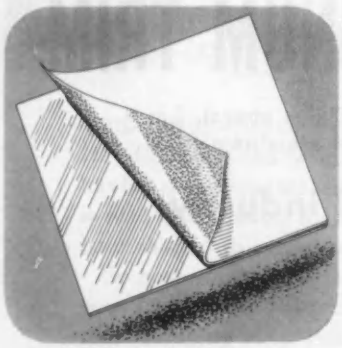
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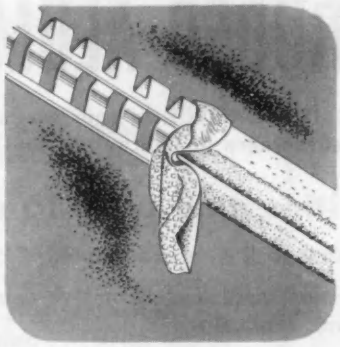
Bonding textile to textile



Bonding synthetic foam to metal in auto armrest



Bonding "Teflon"* to steel
*A Du Pont trademark



Sealer for automobile window channel

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R/M Bulletin No. 700 contains engineering information you will want on Ray-BOND adhesives, protective coatings and sealers. Write for your free copy.



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So thin and flexible — handles like fabric

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Patents Pending

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Tested on thousands of engines in the past year, **Victocor** is setting new standards for high-compression sealing. It insures maintenance of original compression ratio and maximum power production. It outperforms all other gaskets.

Completely new in concept, **Victocor** is thin and "soft" . . . flat and flexible. It uses no beading, grommets or flanges. It combines the resilience of rubber . . . the heat resistance of asbestos . . . the strength of steel. It handles as easily as fabric.

Fast Heat Transfer, the Secret

Exclusive thin steel core construction highly accelerates **Victocor's** heat conductivity. It's done with projections from the core, formed alternately on each face. Type 200, for example, has 800 such projections per sq. in.

The sealing element—a special asbestos-elastomeric compound—is bonded simultaneously to core face. This structure prevents loss of torque due to collapsing and pounding under heavy load. It has dimensional stability. It positively retains all coolants.

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Now in use as original equipment, **Victocor** head gaskets far exceed ordinary sealing requirements. Their extreme resiliency compensates for mating surface irregularities. They need no pre-coating on installation, yet come off without difficulty.

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Samples Free — 4 Types — Specification Non-Rigid

In four basic types, **Victocor** offers a new degree of balanced resilience and heat resistance. Any type can be modified to your application—in core or packing, gauge or structure. It's the **Victocor** construction that assures good performance.

Complete data on types, sizes, physical properties—also test samples—sent on request. And Victor Engineers will be glad to work with you, without obligation.

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GASKETS · OIL SEALS · PACKINGS · MECHANICAL SEALS



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Caterpillar

STEERING linkage, engineered and manufactured by Thompson Products' Michigan Division, isn't only used on leading passenger cars. Heavy duty vehicle manufacturers count on Thompson too, as you can see from some of the big jobs above. All of them are equipped with Thompson chassis parts.

Thompson is continually being called upon by the automobile, truck, farm machinery and off-the-road vehicle manufacturers to come up with new ideas and new manufacturing. Why don't you call or write Thompson's Michigan Division now for help with your problems. The address is 34201 Van Dyke, Warren, Michigan; the telephone number Jefferson 9-5500.



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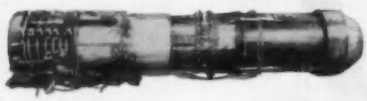
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HEIM *Unibal*® Rod Ends

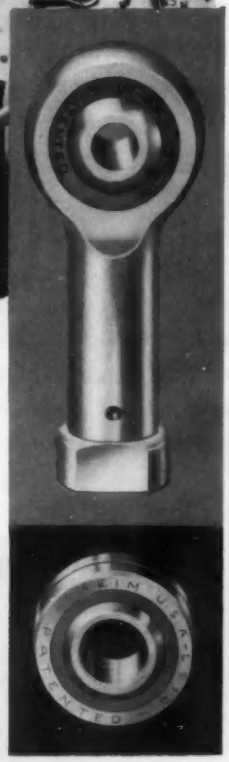
...in good company...



The new General Electric J79 jet engine has the highest thrust-to-weight ratio of any aircraft power plant in production. The engine is rated in the 10,000-pound thrust class.

Variable stators are used for the first time in a flying jet engine, which in a mechanically simplified way, and with far less weight, accomplish the same thing that the dual rotor does in other current engines. The device provides a smooth flow of air inside the engine and eliminates the "stall barrier" problem.





HEIM UNIBAL SPHERICAL BEARINGS and ROD ENDS supply the exact type of linkage, mounting, and degree of misalignment correction required by this engine, and The Heim Company is proud of its contribution to the success of the GE J79.

There are over 200 Unibal Rod Ends assembled with the variable pitch stator blade operating levers.

There are over 50 LS type Unibal Spherical Bearings used as pivot points for the inlet guide vanes.

The bearings which mount the engine to the airframe are three Heim Unibal cartridge units. These bearings carry the entire weight of the engine *and its thrust*.

Other Heim bearings of various types used on this engine bring the total to around 500.

* * * *

The load carrying capacity of Unibal spherical bearings is very high. They are applicable in any linkage where motion must be transmitted at constant or varying angles. They are ideal as supports to any device which is subject to mechanical or thermal deflection.

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THE HEIM COMPANY, FAIRFIELD, CONNECTICUT



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Entering or expanding export operations with powered products calls for a very special kind of global strategy. More than ever, you need product power with a global reputation for dependability and economy. And you need engines backed by world-wide parts and service support.

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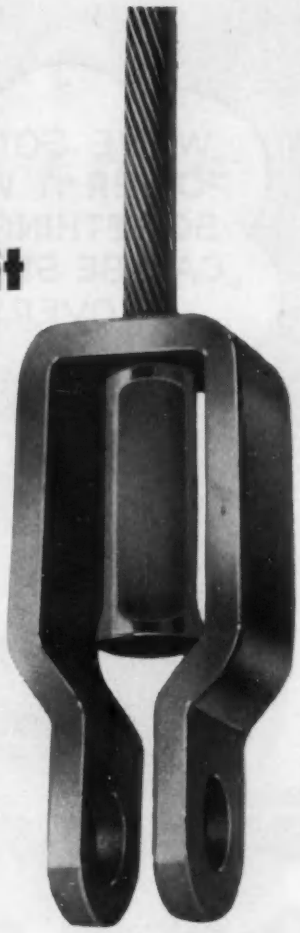
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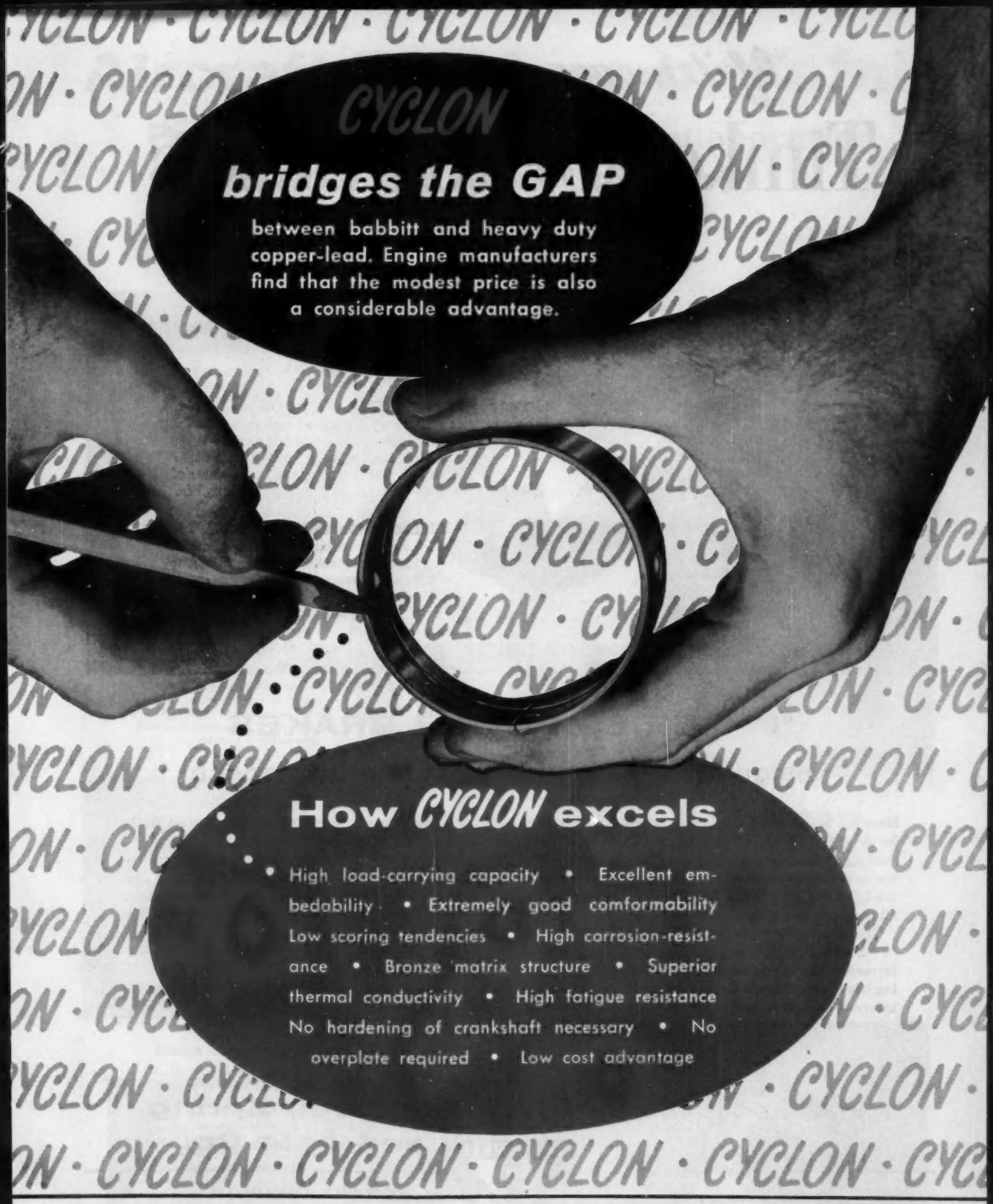
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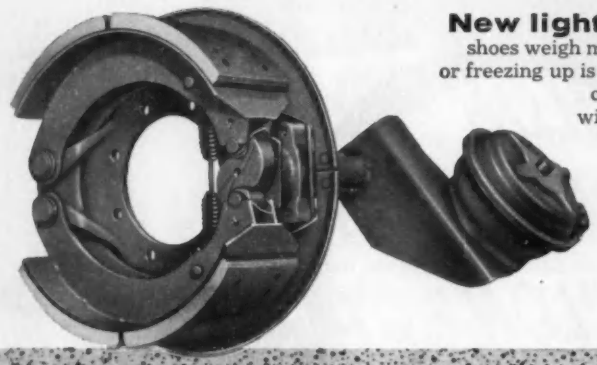
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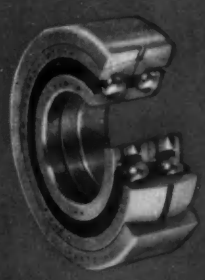
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☐ Is the retainer roller-supported, to reduce sliding friction?

Retainer Construction

☐ Is the retainer strong enough to withstand shock loads and sudden reversals?

(A Rollway segmented-type steel retainer, such as that illustrated, is the strongest, most durable available in commercial grade bearings.)

Roller Spacing

☐ Are all rollers equally separated, or do some rub against each other in opposed-motion friction?

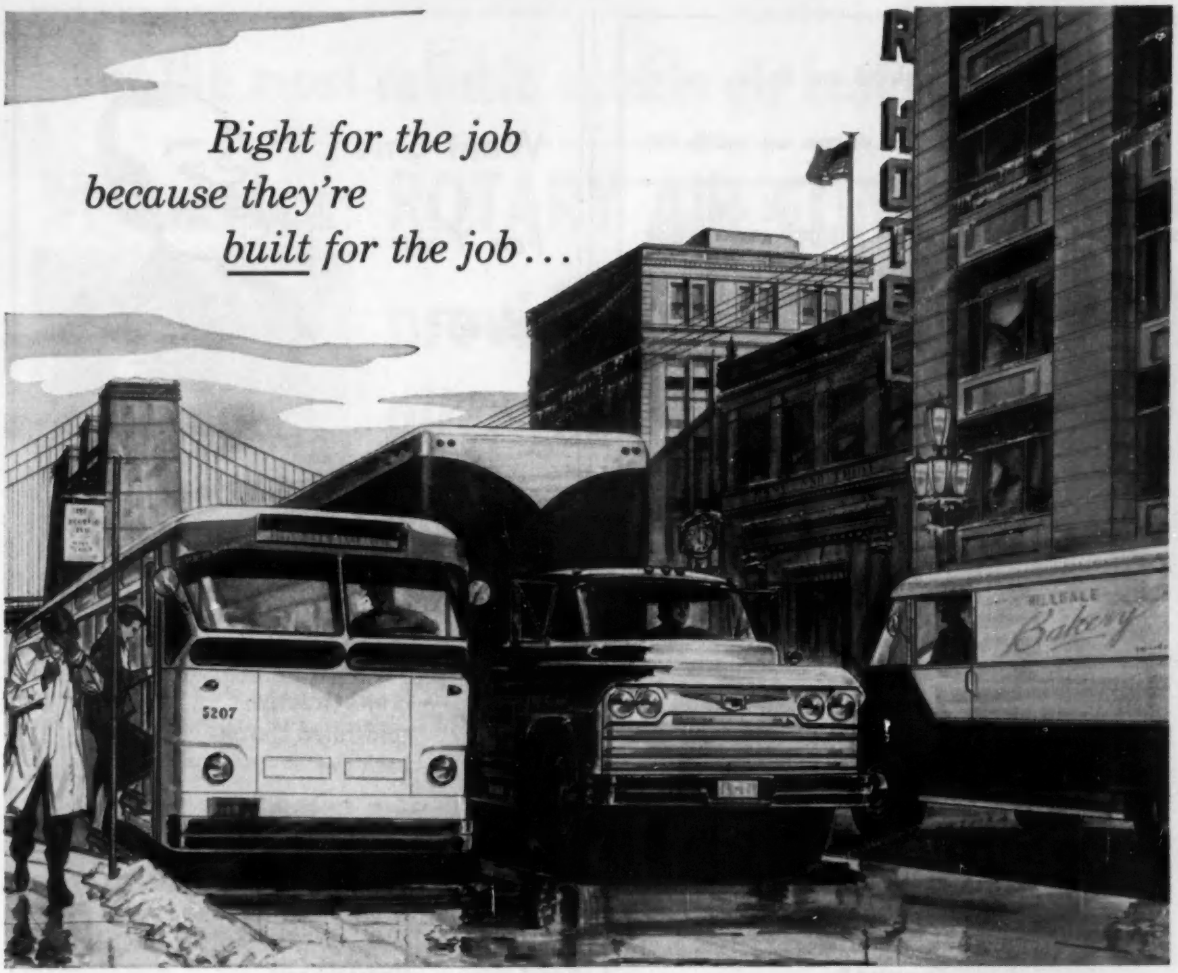
☐ Are rollers distributed evenly to prevent "pulse" and vibration?

Roller Construction

☐ Are the rollers crowned for optimum load distribution?

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ROLLWAY® Tru-Rol ROLLER BEARINGS



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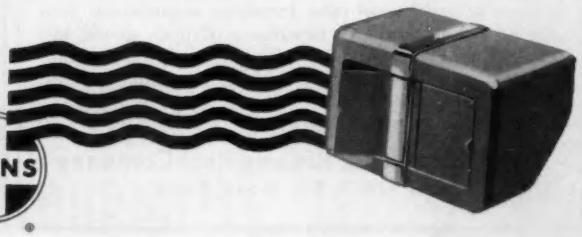
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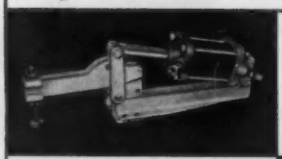


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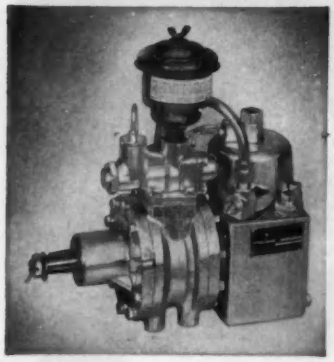
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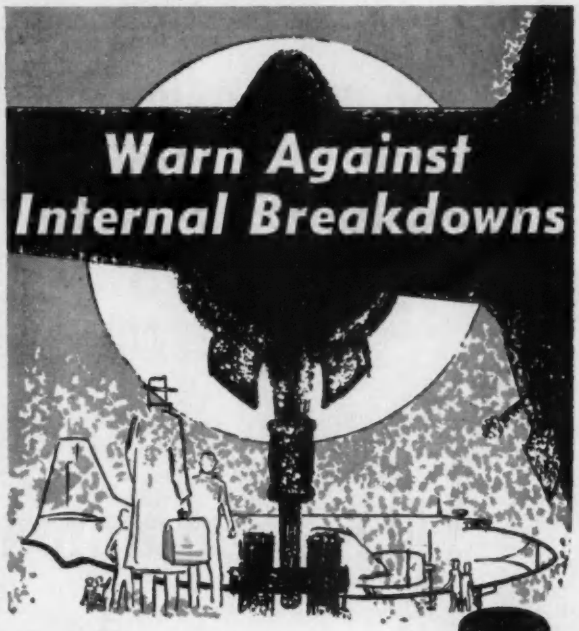
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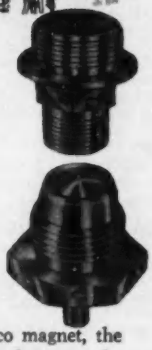
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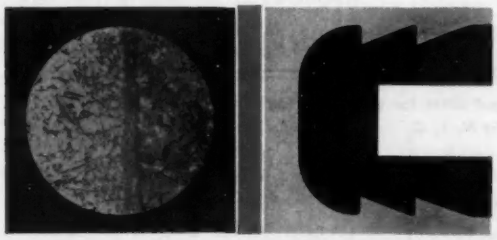
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Photomicrograph of Bi-metallic Molecular Bond

Enlarged Cutaway of Ni-resist Armored Ring Band



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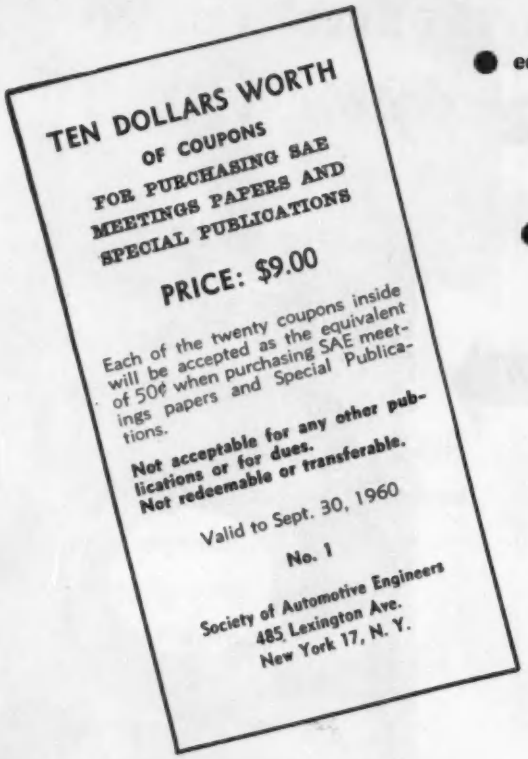
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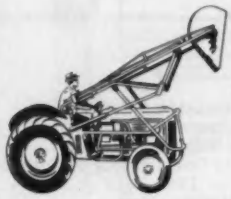
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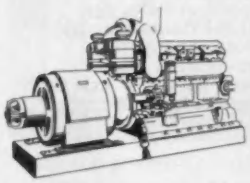
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Length — in.	8.5	10.5	12.9	14.7
Weight — lb.	24.0	40.0	95.0	112.0

THE GARRETT CORPORATION

AiResearch Industrial Division

9225 South Aviation Blvd., Los Angeles 45, California

DESIGNERS AND MANUFACTURERS OF TURBOCHARGERS AND SPECIALIZED INDUSTRIAL PRODUCTS

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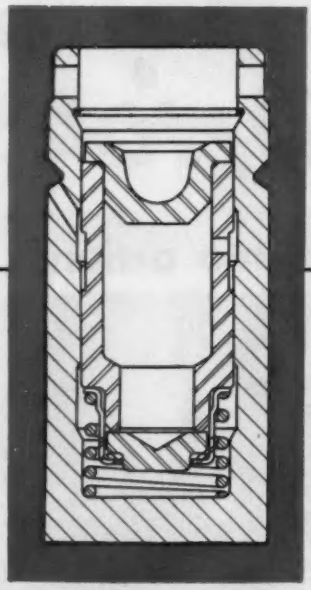
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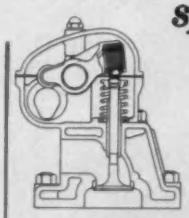
Zollner Corp. 168

Designing valve gear?

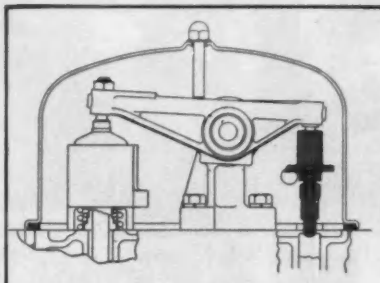
We invite you to use these specialized CHICAGO services



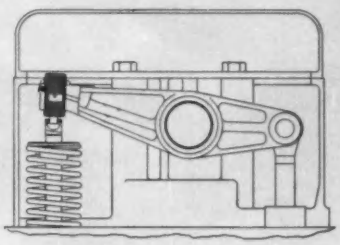
CHICAGO SPRING-LOADED FLAT VALVE HYDRAULIC TAPPET



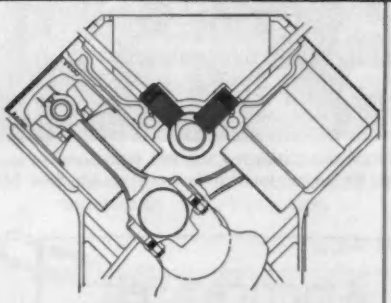
INSERT TYPE ROCKER ARM UNIT



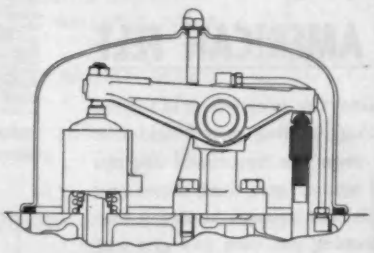
PUSH ROD TYPE FOR COMPRESSION RELEASE APPLICATION



THREADED TYPE ROCKER ARM UNIT



V-8 AUTOMOTIVE HYDRAULIC TAPPET APPLICATION



HYDRAULIC UNIT ON END OF PUSH ROD

Design

of complete valve gear installations for any type of engine . . . passenger car, truck, tractor, diesel, aircraft or industrial.

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based on years of specialized experience in valve gear problems. The skills of our engineers will prove a valuable addition to your own engineering staff.

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CHICAGO's facilities insure precision-manufacturing, scientific testing and rugged, trouble-free performance in every tappet. We will welcome the opportunity to serve you.

THE CHICAGO SCREW COMPANY

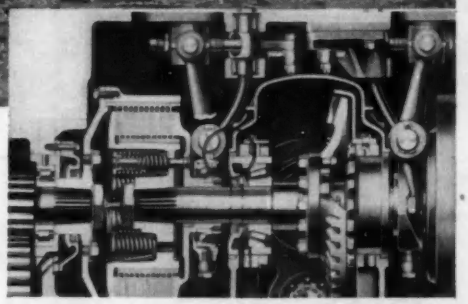
ESTABLISHED 1872 • DIVISION OF STANDARD SCREW COMPANY

2701 WASHINGTON BOULEVARD, BELLWOOD, ILLINOIS

Dust Flies Fast and Furious

. . . when the TRAXCAVATORS* go into action!





CUTAWAY of a Caterpillar No. 955 Traxcavator to show one of the spots protected by seals of American Felt.

But vital innards are kept grit-free and oil-tight with seals of AMERICAN FELT

The Traxcavator, made by Caterpillar Tractor Co., is called on to handle some mighty tough jobs. Logging, grading, loading gravel and dirt are just a few. Under these conditions even the best-made engines and machines need their vitals protected against grit, dust, water and mud, and at the same time have the oils and greases kept grit-free and sealed in. To do this dual job of keeping out dust and grit and keeping in oil and grease, Caterpillar Tractor Co., Peoria, Illinois uses seals of American Felt . . . in their D4 Tractor, No. 955 Traxcavator shown and other pieces of equipment . . . to insure reliable performance and long life.

American makes various types of felt for sealing purposes, and supplies it as desired, including the very important laminated synthetic rubber and felt OILFOIL seal, cut to size. For information, write for Data Sheet No. 11, "Felt Seals, Their Design and Application."

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General Offices
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the NEW AMPlivar splice plus new horizontal machine

for identical, mass produced splices of enamel, poly-vinyl acetal and similarly coated wire



AMPlivar splices can be used on solid or stranded conductors, or combinations thereof.

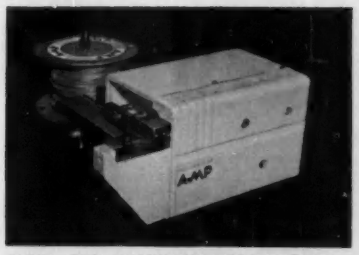
AMPlivar splices, with multiple ring stripping action, eliminate scraping, dissolving in solvents, burning, or other methods for removing insulation. Included among its many other features are:

- NO HEAT DAMAGE TO WIRE OR INSULATION—as often occurs in alternate methods of splicing.
- SMALL SIZE—scarcely larger than the wires themselves, but design-engineered to lock wire and connector into a high tensile strength splice.
- CORROSION RESISTANT—the joint is hermetically sealed during splicing.
- LOWER INSTALLED COSTS—eliminates soldering materials and equipment . . . requires less wire . . . reduces time required to make the splice.

Further information is available on request.



This cutaway of the AMPlivar splice shows how conductor material extrudes outwardly into serrations for added strength and electrical contact. The splice is as corrosion resistant as the wire itself.



IDEAL FOR ASSEMBLY LINE PRODUCTION . . . the AMP Horizontal Automachine uses AMPlivar splice connectors in strip form, for automatic splicing as fast as the operator can insert the wires.

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How to speed up your automatic forging operations ...at no extra cost

TO get the continuous, fast operation vital to making the most of your automatic forging production lines, you need uniformity in the steel you use. High speed heat-treating and hardening operations are often interrupted by changes in chemical composition and structure of steel used. Uniformity cuts interruptions for adjustments. It helps you gain the full advantages of automatic operation. And you get the utmost in uniformity—at no extra cost—by using Timken® electric furnace fine alloy steel. It's uniform from bar to bar, heat to heat, order to order.

We take many extra quality-control steps to insure this uniformity. Some of them were "firsts" in the steel industry. For example, a magnetic stirrer for molten steel assures equal distribution of alloys, uniform temperature and working of the slag. And the Timken Company was also first to use a direct-reading spectrometer to insure uniform grain size and chemical composition right to the instant the heat is tapped.

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So to step up your automatic forging operations—at no extra cost—always specify Timken fine alloy steel. You'll get uniform results, faster, continuous production, time after time. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

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